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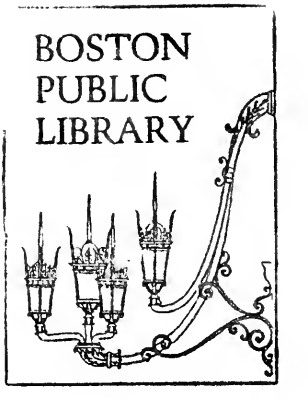
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BASE BUILDING SPECIFICATION SECTIONS 15400, 15500, 16010

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July, 15 1991

Vertec Corporation
Belmont West Office Park
Brockton, Massachusetts 02401

Att: Mr Charles Wilson

re: Roxbury Corners Commercial Tenant Fit-up
Jack's Men Shop

Dear Mr. Wilson;

You are invited to submit a contract price for the commercial tenant fit-up work as indicated on the enclosed drawings titled Jack's Men Shop, drawings A-1 and E-1 and Roxbury Corners Housing drawing HV. The scope of work consists of the addition of a partition wall and door and miscellaneous electrical work within the Jack's Men Shop Store. In addition, the work consists of adding duct work, diffusers and return air grills to Jack's Men Shop as well as three (3) other commercial areas as shown on drawing H-V. This contract price should be a lump sum price. The price shall be broken into two lump sums, one for work pertaining to the A-1 and E-1 drawings and one for the work pertaining to the H-V drawing.

The base building contract drawings P-7 thru P-13, H-6 thru H-12, E-1 and E-10 thru E-17 and specifications are to be followed as they pertain to the spaces Applicable base building drawings and specification sections are included herewith. Base building shop drawings will be made available to the the Contractor after award of the Contract.

The dead line for submitting a price is July 23, 1991 You will be responsible for confirming actual as-built conditions. Please call within this time period to set up a site visit if you so desire. Please also call if you have questions.

Very truly yours,
Domenech, Hicks and Krockmalnic Inc., Architects

Karen Breslawski, AIA
Associate

cc: file 38708
J. Juhl, TCB
V. Hyman, UDC
M. Lewis, BRA
FJD, Jr, DH&K

J. Domenech, Jr., AIA
Michael Hicks, AIA
Krockmalnic, AIA, ASID
Breslawski, AIA
Alicia J. Gallagher

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PART 1 - GENERAL

1.01 REFERENCE

A. The GENERAL DOCUMENTS, as listed on the the Table of Contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made a part of this Section.

1.02 DESCRIPTION OF WORK

A. Complete domestic cold water systems shall start with new connections to the existing water mains in Washington Street and Northampton Street. The systems shall connect to all plumbing fixtures and equipment including water meters.

B. Complete domestic hot water systems for Parcels 29-a, SE-70 and SE-71 shall be generated by the central gas fired storage heaters located in the boiler rooms.

C. Complete soil, waste and vent system connecting to all plumbing fixtures and equipment. Vents shall extend through roof. Soil and waste lines shall flow by gravity to a point 5'-0" outside foundation wall.

D. Complete exterior sanitary collection system including manholes and final connections to the sanitary mains in Washington Street and Northampton Street.

E. Complete gas systems starting with new connections to the existing gas mains in Washington Street and Northampton Street. Systems shall include regulators/meters assemblies and connect to all gas fired equipment. Make all necessary arrangements and pay all costs for the new exterior gas services for this project.

F. Complete interior storm water collection system connecting to all roof and deck drains. System shall flow by gravity and terminate 5'-0" outside foundation wall.

G. All plumbing fixtures, supports and related trim.

H. Insulation for all water piping.

I. Buildings shall have complete sprinkler and standpipe coverage. Systems shall consist of a combination standpipe/sprinkler system. Systems shall start with a new connection to the existing water mains located in Washington Street and Northampton Street.

Standpipes with 2-1/2" fire department and sprinkler control valve at each level.

J. Building fire protection which shall consist of a combination sprinkler, standpipe systems fed through a fire pump with jockey pump and controls. Standpipes shall be located in stairwells and interior locations as indicated, complete with 2-1/2 inch fire

department valves and valved sprinkler supply branches with water flow indicator assembly continuing to sprinkler heads on each level to provide complete sprinkler and fire hose coverage. System shall start with a connection to the exterior city water main valved branch located in street, underground piping to building shall be provided with bridle rods at all bends and shut-off valve at the interior building entrance point.

K. Provide all valves specified herein and/or indicated including vacuum relief, temperature and pressure relief, shut-off, balancing, checks, drains valves, fire department valves, standpipe hose (fire department) valves, fire pump test valves, hose bibbs, pressure reducing valves, flush valves, backflow preventers, wall hydrants, plug cocks and other valves specified herein.

L. Install toilet room accessories furnished under Division 10.

M. Furnish access panels for installation by the related trades of surfaces in which they are located.

N. Provide all floor and roof drains, cleanout plates and pipe cleanouts.

O. Provide hangers, sleeves, anchors, inserts, strainers, gauges, thermometers, plus related accessories required for a complete installation of each system specified and/or indicated.

P. Provide supplementary steel for piping and equipment supports.

Q. Provide tests, balancing and sterilization of systems specified herein.

R. Provide color coding, valve tags and charts.

S. Provide operating and maintenance manuals.

T. Provide guarantee.

U. Provide shop drawings, record drawings, coordination drawings, refer to Division 1.

V. Provide required cutting and patching, refer to Division 1.

W. Provide temporary water piping system, refer to Division 1.

X. Provide required cleaning and rubbish removal, refer to Division 1.

Y. Cost of new water meters, installation, furnished and installed by City water department authority, shall be borne by this contractor.

Z. Provide special shop drawings relative to fire protection systems as follows: Before buying or installing any fire protection equipment, prepare and submit required number of approved sets of shop drawings to scale, of complete fire protection systems to

Architect. Shop drawings shall have been previously approved by I.S.O. (Insurance Service Offices) and stamped after review, by appropriate Insurance Underwriters or Authorities as required by Owner.

AA. Under this Section of the Specification, maintain standpipe coverage at all time during construction. Coverage shall consist of standpipes plugged at one floor level below progress of construction with a minimum of one 2-1/2 inch fire department valve provided on each standpipe and active at all times.

1.03 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

A. Toilet Room Accessories and certain accessories specified under Division 10 shall be installed under this Section of the Specification.

B. Excavation, backfilling, exterior storm drainage, trenching, pumping, shoring and rough grading, repair of existing streets and sidewalks excavated in conjunction with installation of new Utilities shall be as specified under Division 2.

C. Painting, except as specified herein, including color coding of pipes, specified under Division 9.

D. Access panels, furnished under this Section, to be installed under the related trades of the surfaces in which they are located.

E. Electrical wiring, disconnect switches, and motor starters for all motors, unless otherwise specified herein, to be furnished and installed under Division 16.

F. Final electrical connections to fire pump, jockey pumps, hot water circulating pumps, all controls, valve monitor switches, flow indicators, bells, supervisory panels - Division 16.

G. Temporary heat, electricity, and toilet facilities, specified under Division 1.

H. Concrete thrust blocks, pits, trenches and equipment bases, including grouting of all pumps and equipment - Division 3.

I. Manholes - Division 3.

J. Fire extinguishers to be provided under Division 10.

K. Foundation drainage piping system - Division 2.

L. Condensate drains from Air Conditioning Equipment - Division 15.

M. Boiler for heating, flue pipes for gas fired hot water heaters, final connections and boiler gas supply (including approved gas train) and cold water make-up for heating system - Division 15.

N. Trash chute interior fire protection and washing systems - Division 14. Final connections to each system (water and fire protection) by the Plumbing Subcontractor.

O. Provide necessary supervision and coordination information to any other trades involved in construction to accommodate space, support or service to install plumbing - fire protection, equipment.

1.04 CODES, PERMITS AND FEES

A. Unless otherwise specified or indicated, materials and workmanship and equipment performance shall conform with the latest edition of the following standards, codes, specifications, requirements, and regulations but not limited to:

1. All applicable NFPA standards.

2. Commonwealth of Massachusetts Plumbing, Gas and Building Codes.

3. American Society of Mechanical Engineers.

4. American Society of Testing and Materials.

5. American National Standards Institute.

6. National Electrical Manufacturer's Association.

7. Underwriters' Laboratories, Inc.

8. Occupational Safety and Health Administration.

9. City of Boston, Massachusetts Ordinances.

10. American Water Works Association.

11. Compressed Gas Association.

B. Any other local codes and/or authorities (governmental or public utility) having jurisdiction including any other standards specifically indicated in other paragraphs of this Specification.

C. Under this Section of the Specifications, pay all fees, submit all necessary documents, obtain all permits and certificates and all necessary approvals from authorities (governmental or public utility) having jurisdiction, provide copies of all permits, approvals and certificates to the supervising Architect for his record. All costs for these requirements shall be borne under this Section of the Specification.

D. New Street Connections:

1. The complete cost for each new piping connection to the existing sanitary sewers and water main branches in the street shall be borne by this Contractor. Included in the cost for

each new connection shall be excavation, backfilling, pumping and shoring, valves, manholes and all necessary refinishing of the existing streets and sidewalks disturbed to perform the aforementioned work.

1.05 ELECTRIC MOTORS

A. Motor shall be built in accordance with latest standards of NEMA and as specified. Motor shall be specifically and expressly wound for voltage required.

B. Motor shall be tested in accordance with standards of ANSI C50 and conform therewith for insulation resistance and dielectric strength.

C. Motor shall be provided with adequate starting and protective equipment as specified or required and with conduit terminal box of size adequate to accommodate conduits and wires as sized on electrical drawings or specified under this Section of the Specification.

D. Capacity shall be sufficient to operate associated driven devices under conditions of operation and load and with overload and at least horsepower indicated or specified. All motors shall be of the high efficiency, low energy consuming type most suitable for the application and its specific environmental location in this building. All motor replacements necessary for compliance to the application shall be at no additional cost to the Contract.

E. All motors shall be suitable for continuous duty at rated horsepower with temperature rise not to exceed 40 degrees C for drip-proof motors, 50 degrees C for splash proof motors, 55 degrees C for totally enclosed or explosion-proof motors. All motors shall be capable of 25 percent overload without overheating and suitable for operation for the ambient conditions of its specific location in the building.

F. Direct connected motor shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except fractional HP motors, which have slotted mounting holes.

G. All motors "rpm" shall be within the specified acceptable range to avoid noise and vibration transmission to the building structure.

H. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed and current characteristics.

I. Motors smaller than 1/2 horsepower shall be capacitor-starter or phase type designed for 120 volts, single phase, 60 cycle operation unless otherwise specified. This shall be coordinated with work under Section 16100 Electric.

J. Motors 1/2 horespower and larger shall be squirrel cage induction type designed for 208 volts, three-phase, 60 cycle operation unless otherwise specified.

K. Installation of Motor control equipment will be indicated under Section 16010 Electric as shown on the drawings for control and operation of the plumbing - fire protection equipment.

1.06 SURVEYS AND MEASUREMENTS

A. Under this section of the Specification, base all required measurements, both horizontal and vertical, from referenced points established by the Architect and be responsible for correct laying out of the work required under this Section of the Specifications.

B. In the event of discrepency between actual measurements and those indicated, notify the Architect in writing and do not proceed with the work required under this Section of the Specification until written instructions have been issued by the Architect.

1.07 COORDINATION

A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow speedy and efficient completion of the project.

B. Furnish to all other trades advance information on location and sizes of all frames, boxes, sleeves, and openings needed for the work under this Section of the Specifications and also furnish information and shop drawings necessary to permit trades affected by the Plumbing - Fire Protection work to install their work properly coordinated and without delay.

C. Where there is evidence that work installed under this Section of the Specifications interferes with the work of other trades, assist in working out space conditions to make satisfactory adjustments.

D. With the approval of the Architect, and without extra cost to the Owner, make reasonable modifications in work specified under this Section of the Specifications required to coordinate with normal structural interferences, or for proper execution of specified work.

E. If work is installed before coordinating with other trades, so as to cause interference with the work of such trades, make all necessary changes in work under this Section of the Specifications at no additional cost to the Contract.

F. Protect all materials and work of other trades from damage that may be caused by the work required under this Section of the Specifications and be responsible for repairing any damages caused by such work at no additional cost to the Contract.

1.08 CUTTING AND PATCHING

A. When, in order to accommodate the work required under this Section of the Specifications, finished materials of other trades must be cut or fitted in the shop, furnish the necessary drawings for transmittal to the trades whose materials must be cut or fitted.

B. Do all drilling and cutting of holes in concrete walls and floors for the installation of sleeves and supports provided under this Section of the Specification.

C. Pay costs for additional cutting and patching caused by ill-timed, incorrectly preset materials or defective plumbing and fire protection work, or plumbing and fire protection work not conforming to Contract Documents, including costs for additional services of Architect, if work under this Section of the Specifications is responsible for ill-timed, rejected, incorrectly located, or non-conforming work.

1.09 ACCESSIBILITY

A. All work provided under this Section of the Specification shall be installed so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from Architect.

1.10 ACCESS PANELS

A. Furnish access panels for installation in walls, ceilings and floors at locations indicated or as specified herein to permit access for adjustment, removal and replacement and servicing of all concealed equipment and materials provided under this Section of the Specifications.

B. Access panels will be installed under the Section of the related trades of the finished surfaces in which they are located.

C. All access panels shall be located in a workmanlike manner, also in closets, storage rooms and/or other non-public areas, positioned so that the equipment can be easily reached, and the size shall be sufficient for this purpose (min. 16 inch x 16 inch). When access panels are required in corridors, lobby or other habitable areas, they will be located as directed by the Architect.

D. Access panels shall be prime painted and provided with cylinder lock and two keys as manufactured by Milcor, Inland Steel, Miami Carey or approved equal.

1. Dry Wall Surfaces Milcor Type DW

2. Masonry Construction Milcor Type M

3. Acoustical Tile Ceiling Milcor Type A

4. Plastered Surfaces Milcor Type K

E. Access panel shop drawings shall be submitted to the Architect for approval.

1.11 FIREPROOFING

A. All clips, hangers, clamps, supports and other attachments to the fire rated structure, required for work provided under this Section of the Specifications, shall be coordinated with concrete and structural steel trades in order to avoid any damage to the fireproofing.

B. All piping and other items which would interfere with the proper application of fireproofing shall be installed after the application of fireproofing.

C. Pay the cost of all additional patching and repairing of fireproofing due to cutting or damage to the fireproofing by the installation of work provided under this Section of the Specifications.

1.12 PORTABLE OR DETACHABLE PARTS

A. For all work provided under this Section of the Specifications, retain in possession and be responsible for all portable and/or detachable parts and portions of the installation and all other devices or materials that are relative to and necessary for proper operation and maintenance of the plumbing - fire protection systems until final completion of the Contract, such items shall be given to the Architect for transferal to the Owner.

B. Replace, free of cost, all stolen, lost or damaged items provided under this Section of the Specifications relative to the installation and operation of the plumbing - fire protection systems before the building is accepted by the Owner.

1.13 FIELD DRILLING

A. Field drilling (core drilling) when required, shall be performed under this Section of the Specifications, after receipt of approval by the Architect.

1.14 TOOLS, EQUIPMENT, STAGING AND HOISTING EQUIPMENT

A. Necessary tools and equipment such as pipe bending machines or staging for erection of equipment shall be furnished at job site under this Section of the Specifications for fabrication and erecting all related equipment covered by this Section of the Specification.

B. Refer to Division 1 for provisions in hoisting.

C. Concrete bases and supports for equipment and piping; including grouting will be furnished and installed under Division 3.

1. Under this Section of the Specification, furnish required foundation sizes, bolts, washers, sleeves, plates, templates for plumbing and fire protection equipment.

2. The size of the foundation bolts shall be as recommended by the manufacturer.

3. Equipment shall be set on the foundation and shimmed level with steel shims, then grouted for uniform bearing.

1.15 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all piping and equipment provided under this Section of the Specification.

B. Supplementary steel and factory fabricated channels shall be firmly connnected to building construction in a manner approved by the Architect; as shown on the drawings or hereinafter specified.

C. The type and size of the supporting channels and supplementary steel provided under this Section of theSpecifications shall accommodate all deflections in conformance with the manufacturer's requirements for the specific loading on the system installed therein.

D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.

E. All supplementary steel including factory fabricated channels, supports and fittings shall be Underwriters' Laboratories, Inc. approved, shall be galvanized steel, and shall be manufactured by Unistrut, Powerstrut or approved equal.

1.16 CROSS AND INTER-CONNECTIONS

A. No plumbing fixtures, equipment, devices or piping shall be installed which will provide a cross or inter-connection between a distribution water supply for drinking or domestic purposes and nonpotable supply or a drainage system soil or waste pipe which will permit or make possible the backflow of sewerage, polluted water or waste into the domestic water supply system.

1.17 TYPICAL DETAILS

A. Typical details where shown on the drawings shall apply to each and every item of the plumbing-fire protection work where such items

are applicable. They are not repeated in full on the drawing, which in many cases are diagrammatic only, but with the intention that such details shall be incorporated in full. Any alternate methods proposed to be provided under this Section of the Specifications shall have prior written approval from the Architect before installation.

1.18 SHOP DRAWINGS

A. Shop drawings shall be submitted in accordance with requirements specified in Division 1.

1. Where, under this Section of the Specification, a proposal has been made to use an item of material or equipment other than that shown or specified in the Contract Documents, this Contractor shall assume the cost of and entire responsibility of coordination with all other trades involved. In addition, make such arrangements and assume costs occasioned by changes in the work of other trades that may be required in order to install the approved substitution; such changes shall not be a matter for subsequent Change Order for extra work to the Contract.

B. List of Shop Drawings:

1. Piping, fittings and accessories.

2. Valves and cocks including vacuum, pressure and temperature relief valves, balancing valves, check valves, drain valves, wall hydrants, standpipe hose valve, fire department connection, roof manifold and flow control fittings.

3. Hangers and supports including supplementary steel.

4. Thermometers and gauges.

5. Strainers.

6. Flow switches and monitor switches.

7. Sprinkler heads, sprinkler layouts and hydraulic calculations.

8. Backflow preventors and water meter.

9. Plumbing fixtures and related trim.

10. Insulation.

11. Hot water heaters and recirculating pump.

12. Floor drains, roof drains and cleanouts.

13. Access panels.

14. Sleeves and escutcheons.

15. Test certificates.

16. Fire Pump, Jockey Pump and all Controls.

17. Fire pump test valves, test hose cabinet, and wall connection.

18. Fire department valves.

19. All wiring diagrams indicating the sequence of operation, sequence of interlocking and operation of alarms.

20. Sump pumps.

1.19 DEFINITIONS

A. As used in this Section, the following terms are understood to have the following meaning:

1. The Contractor shall mean the Trade Contractor.

2. Furnish shall mean purchase and deliver to the project site, complete with every necessary appurtenance and support.

3. Install shall mean unload at the delivery point at the site and perform all work necesary to establish secure mounting and proper location in the project.

4. Provide shall mean "Furnish" and "Install".

5. Work means all labor, materials, equipment, apparatus, controls, accessories, and all other items required for a proper and complete installation.

6. Piping includes in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

7. Concealed means hidden from sight as in service strips of kitchen, in chases, furred spaces, shafts, hung ceilings, embedded in construction.

8. Exposed means not installed underground or concealed as defined above.

9. Any work by others means work not provided under this Section of the Specification but work furnished and/or installed under other Sections of the Specification within this Contract.

10. Coordinate means all plumbing-fire protection work provided under this Section of the Specification shall be in compliance with work of other trades.

11. O.P. means systems operating pressure.

12. Bypass, where used in connection with piping shall include one globe valve for throttling, two gate valves for shutoff, pipe and fittings.

13. Indicated shall mean Indicated on the Contract Drawings.

14. Herein shall mean the Contents of a particular Section where this term appears.

1.20 TECHNICAL ABBREVIATIONS

A. TDH - Total Dynamic Head.

B. C.I. - Cast Iron.

C. RPM - Revolutions Per Minute.

D. HP - Horsepower.

E. GPM - Gallons Per Minute.

F. PSIG - Pounds Per Square Inch Gauge.

G. ^{o}F - Degrees Fahrenheit.

H. ^{o}C - Degrees Centrigrade.

I. CFM - Cubic Feet Per Minute.

J. KW - Kilowatt.

1.21 DRAWINGS, SPECIFICATIONS AND COORDINATION

A. It is the intention of these Contract Documents to call for complete, finished work, fully tested and ready for continuous operation.

B. Any apparatus, appliance, material or work not shown on the drawings but mentioned in the specifications, or vice versa, or incidental accessories necessary to make work complete and perfect in all respects and ready for operation even if not particularly specified, shall be furnished, delivered and installed under this Section of the Specifications without additional cost to the Contract.

C. Should there appear to be discrepancies or question of intent in the work to be done under this Section of the Specifications, refer the matter to the Architect for decision before ordering any materials, or equipment or before start of any related work. Interpretations of the Architect shall be final, conclusive and binding.

D. Drawings are generally diagrammatic and are intended to convey scope of work and indicated general arrangements of equipment, piping, fixtures, etc.

E. Location of items indicated, that are not definitely fixed by dimensions are approximate only. Exact locations necessary to secure best conditions and results must be determined at the project and shall have the Architect's approval before being installed.

F. Follow drawings in layout work and check drawings of other trades to verify spaces in which work provided under this Section of the Specifications will be installed and maintain maximum headroom or space conditions at all points, where headroom or space conditions appear inadequate, notify the Architect before proceeding.

G. Attend regular coordination and job progress meetings as required by the Architect.

H. Provide and maintain on site a field office and storage facilities as specified under Division 1.

I. Maintain premises and public properties free from accumulations of waste, debris, and rubbish caused by Plumbing/Fire Protection construction work.

J. Maintain a clean, dry, legible and current record drawings as specified under Division 1.

1.22 SUBCONTRACTS

A. Wherever hereinafter guarantees of durability, operating capacity, proper functioning of equipment and the like are called for in this Section of the Specifications or wherever it is specified herein that the manufacturers shall furnish detail drawings, test certificates, or performance curves, that the manufacturer shall supervise the installation, keep it in repair for a stated period, or render other similar services, responsibility for the performance of the specified service under the actual conditions of installation shall be included as a part of this Section of the Specifications.

B. The same shall apply to cases where special adjustment by manufacturer or other services are necessary to insure proper and efficient functioning of apparatus, even though not specifically hereinafter called for.

C. In any case where employees, provided under this Section of the Specification, cannot adequately perform the above described service, such performance required by subcontractors, manufacturers, etc., and subsequently payment of any additional fees required therefore shall be included as a part of this Section of the Specifications.

D. Where due to Union Regulations or Trade Agreements, any of the work shown on the Drawings or specified herein is considered work of other trades, the work in question shall be subcontracted as a part of this Section of the Specifications and responsibility for the complete installation shall be included in this Section of the Specifications.

1.23 COORDINATION AND FABRICATION DRAWINGS

A. Refer to Division 1 for coordination drawing requirements.

1.24 SPRINKLER/STANDPIPE SYSTEMS CRITERIA

A. Provide complete combination sprinkler/standpipe pipe system conforming to NFPA Standards #13, 14 and 20, and the requirements of the Commonwealth of Massachusetts; requirements of the Building Department and the local Fire Department and approved by Owner's insuring agency, I.S.O. (Insurance Service Offices). Systems shall consist of the following:

1. Combination standpipe/sprinkler risers and sprinkler risers located in the stair cores.

2. Provide a sprinkler supply branch at each floor off the standpipe risers in stairways. Each riser branch per floor shall include a water flow indicator - inspector's test control valve assembly, including an OS & Y valve with monitor switch.

3. Provide on each floor of each stairway, as indicated, an approved Class I exposed 2-1/2" brass fire department valve with 1-1/2" reducer, cap and chain.

4. Provide siamese wall mounted fire department connections.

5. The entire building shall be sprinklered except in Electrical, Telephone and Elevator Machine Rooms. Provide approved type shields to keep water from discharging directly on electrical and telephone equipment in all other parts of the building.

6. All habitable floor levels shall be protected by light hazard wet pipe sprinkler systems.

7. Sprinkler heads in areas with hung ceilings shall be 165 degrees F, chrome plated, pendant flush with ceiling type heads.

8. Sprinkler heads in unfinished areas without ceilings shall be 165 degrees F, brass upright type. Heads in finished areas without ceiling shall be 165 degrees F. Chrome plated sidewall type.

9. Provide a valved head in elevator shaft. Each valve shall be individually controlled and identified with a metal tag chained to its respective valve.

10. Provide a separate sprinkler system to serve trash chute and trash room at its base.

11. Provide spare sprinkler heads in a cabinet, with signs and other identification markings as required.

B. The location and spacing of sprinkler heads shall be as symmetrical as practical and as required to conform to codes. Sprinkler heads shall not interfere with ceiling suspension system (grid), lighting fixtures, diffusers and partitions. Heads must be reasonably aligned in both directions in all ceiling tiles in all areas. In areas without ceiling tiles, heads must be reasonally aligned in both directions. Pipe shall be run concealed in areas with suspended ceilings and coordinated with piping, conduit and ductwork installations of other trades.

C. Hydraulic calculations shall be submitted to the Owner's Insurers with shop drawings and specifications and shall be approved by the Insurers. Two copies of the approvals from the Insurers shall be forwarded to the Architect for their records.

D. During preparation of the shop drawings, this Trade Contractor shall consult with the Architect and with other Trade Contractors regarding the installation and location of piping, sprinkler heads and devices so that the work may be installed without interfering with the work of others. Additional field coordination shall be furnished by this Contractor when the need arises. Should conflicts arise that cannot be resolved between the various Trade Contractors, these conflicts are to be immediately brought to the attention of the Architect in writing.

E. This Contractor shall deliver to the Architect all certificates of inspections and approvals obtained from all governmental departments having jurisdiction and from the Owner's insuring agency before the certificates for final payment will be given.

F. This Trade Contractor shall be fully qualified to perform this installation as evidenced by a minimum of five years experience and a record of similar installations. This Trade Contractor shall be approved by the Architect.

1.25 STREET SERVICES

A. The sanitary exterior sewers from the property line to the existing sewer (including final connection) when required shall be installed by a Contractor licensed by the city. Costs for the licensed drain laying work specified herein shall be included in this Contractors bid price.

B. Domestic water and fire service connections to the street mains shall be furnished by this Contractor and installed by a person or persons designated by the city Water Department. All costs for the installation including new valves shall be borne by this Contractor and included in his Contract bid price.

C. Cost of supervision, by city water and sewer department authorities, of new water and sanitary sewer final connections to existing street utilities shall be borne by this Trade Contractor.

PART 2 - PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

A. Pipe and fittings shall conform to the latest ANSI, ASTM, NFPA and AWWA Standards including latest amendments.

B. Each length of pipe, each fitting, trap, material and/or device used in the respective system shall have cast, stamped or indelibly marked on it, the maker's name or mark, weight and quality of the product when such marking is required by the approved standard that applies.

C. Storm and Sanitary Drainage Piping:

1. Interior underground sanitary (soil, waste and vent) and storm piping to five feet outside each building wall, unless otherwise specified herein or indicated on the drawings, shall be be service weight cast iron hub and spigot soil pipe and fittings. Piping fittings shall be factory coated. Service weight soil pipe and fittings shall conform to ASTM Specifications A74 and ANSI Standards A112.5.1.

2. Interior sanitary (soil, waste and vent) and storm piping, not buried 1-1/2" and larger, shall be no-hub service weight except at urinals which shall be extra heavy cast iron hub and spigot with lead and oakum joints. Exposed waste and vent piping in Toilet Rooms shall be chrome plated nickel finish.

3. Indirect waste piping shall be Type "DWV" copper tubing with wrought copper solder joint drainage type fittings.

D. Sanitary Sewer and Storm Piping:

1. All exterior storm and sanitary sewer piping from ten feet outside building wall shall be PVC SDR35. PVC sewer pipe and fittings conforming to SDR-35.

E. Water Piping:

1. Interior above ground domestic cold, and hot water supply and return piping shall be Type "L" hard drawn copper tubing with wrought copper solder joint type or cast brass sweat fittings conforming to ASTM Specification B-88, ANSI Standards B16.22, B16.18, and B16.18a, respectively. Flanged fittings shall be Class 150 cast bronze conforming to ANSI Standard B16.24. Exposed water piping in Toilet Rooms shall be chromed plated nickel finish.

2. Exterior buried cold water and fire protection pipe shall be bituminous coated (exterior) ductile iron, cement lined Class 52 with mechanical joints and retainer glands. All pipe and fittings buried in the ground shall be encased in loose 8 mil thick polyethylene film sleeve that complies with ANSI A21.5.

Exterior buried cold water piping serving the townhouses shall be Type "K" soft rolled copper pipe with flared fittings.

3. Sprinkler mains, branches and standpipe system piping shall be Schedule 40 black steel pipe with extra heavy flanged, threaded or victaulic joints and fittings. Schedule 40 black steel pipe with 250 pound threaded type cast iron fittings as approved by NFPA.

F. Gas Piping:

1. Gas piping shall be Schedule 40 black steel pipe with threaded ends and 150 pound black malleable iron flat band threaded fittings conforming to ANSI Standard B16.3.

G. Unions and Flanges:

1. Unless otherwise specified herein, unions, for copper and brass piping; two inches and smaller in diameter shall be one hundred twenty-five pound (steam working pressure) brass ground joint type; larger than two inches in diameter shall be one hundred fifty pound flat faced cast brass flanges conforming to ANSI Standard B16.24. Flanges shall have copper clad steel bolts and nuts and 1/16 inch minimum thickness red rubber full faced gaskets.

2. Where brass flanges and ferrous flanges are to be joined, ferrous flanges shall be full faced.

3. Flanges in gas piping shall be 150 pound screw type with raised face with code approved gaskets.

4. Mating of ferrous and non-ferrous flanges shall be separated with rubber gaskets (1/16 inch minimum thickness) and teflon liners installed in the bolt holes. Bolt holes shall be drilled to receive the teflon liners. Physical contact between the ferrous and non-ferrous flanges including the bolts, nuts and washers will not be permitted.

H. Nipples:

1. Close and shoulder nipples shall be of corresponding materials as specified for the respective piping system and shall be extra heavy.

I. Joints:

1. Joints in cast iron soil pipe above ground shall be made using "Clamp-All" compression type coupling consisting of a neoprene collar, stainless steel coupling with stainless steel bolts and nuts all assembled to provide seal.

2. Joints in cast iron soil piping below ground shall be code approved compression type, made with rubber gaskets conforming

to ASTM Specification C564. Joints in cast iron soil pipe and fittings using a double seal, compression type molded neoprene gasket shall be provided with a modified hub as required to provide a positive seal.

3. Joints in copper tubing except as otherwise specified herein shall be made according to manufacturer's specifications using sweat fittings and 95-5 tin/antimony solder and non-corrosive flux.

4. Steel, copper and brass pipe and fittings with screwed ends shall have IPS threads cut clean and true and in conformance with the ANSI Specifications B2-1 for taper threads.

5. Joints between steel or copper, and cast iron shall be made with Manhoff Fittings screwed into threaded pipe and caulked into the cast iron pipe.

6. Connections between earthenware of any fixture and flanges in soil and waste piping shall be made absolutely gas and water-tight with closet setting compounds and gaskets which must be absolutely gas and fireproof, watertight, stainproof, containing neither oil nor asphaltum and which will not rot, harden or dry under any extreme climatic change, and must adhere on wet surfaces.

7. Before assembly of roll grooved type couplings and fittings on sprinkler - fire line piping, lightly coat pipe ends and outside of gaskets with cup grease or graphite to facilitate installation. Pipe roll grooving shall be in accordance with manufacturer's specifications contained in their latest published literature and NFPA 13.

8. Heat fusion joints in polypropylene pipe shall be made in accordance with manufacturer's instructions.

2.02 PIPE, EQUIPMENT AND VALVE IDENTIFICATION

A. General:

1. All pipe markers, bands, valve tags and equipment identification plates shall be as manufactured by W.H. Brady, Westline Products, Seton Nameplate Company or as approved equal by the Architect.

B. Piping:

1. Name of the service shall be printed in black letters, not less than 2 inches high for piping 3 inches and larger and one inch in height for piping 2-1/2 inches and smaller.

2. Legends, arrows and color band background shall conform to ANSI Standard A13.1 covering "Identification of Piping Systems."

C. Equipment:

1. Nameplates shall be made of black surface white core laminated bakelite with indented letters.

2. Nameplate shall be a minimum of 3 inches long by 1-1/2 inches wide and bear the equipment name as designated in these Specifications.

3. Equipment identification designations shall be taken from equipment schedules as indicated on the drawings or specified herein.

D. Valve Tags:

1. All valves on pipes of every description shall have neat, circular brass valve tags of at least 1-1/2 inches in diameter, attached with brass hook to each valve stem. Stamp on these valve tags in letters as large as practical the number of the valve and the service such as "H.W.", "C.W.", for hot water, cold water, respectively. The numbers of each service shall be consecutive.

2. All valves on equipment, tanks and pumps shall be numbered by 3 inch diameter red metal discs with white numbers 2 inches high secured to stem of valves by means of brass hooks or small solid link brass chain.

2.03 VALVES AND SUNDRIES

A. General:

1. All gate and globe valves shall be designed for repacking under pressure when fully opened, and shall be equipped with packing suitable for the intended service. When the valve is fully opened, the backseat shall protect the packing and the stem threads from the fluid. All gate and globe valves shall have a gland follower. The pressure temperature rating of valves shall be not less than the design criteria applicable to all components of the system.

2. Bronze valves with the basic saturated steam rating of 125 psi or 150 psi shall have pressure containing parts of a material having at least the physical properties of ASTM Specification B-62. Metallic seated bronze globe, angle, check and gate valves with a basic steam rating of 200 to 300 psi shall have pressure containing parts of material conforming to ASTM Specification B-61 for temperatures to 500 degrees F.

3. Pressure containing parts of iron body valves shall be of material conforming to ASTM Specification A-126 Grade B. If the wedge in OS & Y gate valves is fastened to the stem by threads, it shall be secured by a nickel alloy or monel pin.

4. Face to face and end to end dimensions of iron body valves shall conform to ANSI B16.10. Design, workmanship, materials, and testing shall conform to MSS-SP-70 and MSS-SP-71 and MSS-SP-85. (Manufacturers Standardization Society of the Valve and Fitting Industry.)

5. Stems of bronze valves shall be of ASTM B-584 Alloy 876 (cast silicon brass). Stems of iron body bronze mounted valves shall be of ASTM B-371 Alloy 694 (rolled silicon brass), or other material equally resistant to dezincification.

6. All pressure castings shall be free of any impregnating materials.

7. All valves installed in boiler room must conform to ASME boiler code specifications.

8. All valves on fire protection lines shall be approved by the National Board of Fire Underwriters, or the Associated Factory Mutual Fire Insurance Companies. All hose valves shall have threads on outlets conforming to the local fire department specifications.

9. Each valve is to be given shell and seat tests by the manufacturer and will carry a permanently affixed indication that tests have been successfully completed.

10. Insofar as possible, all valves of the same type shall be of the same manufacturer. Before purchasing any valve, Contractor shall submit for approval the name of the manufacturer, the figure number which he proposes to furnish, and engineering data on each figure number, if not using those specified. The intent of this requirement is to obtain the most suitable valve for each service. Non-standard valves will not be considered.

11. Globe valves shall be used to throttle or control the flow.

12. Gate valves shall be used as "SHUT-OFF".

13. Manufacturers valve numbers listed herein is intended only as a guide for the type and quality to be provided under this Section of the Specifications.

B. Gate Valves:

1. Gate valves shall be of the solid wedge type, designed and manufactured in such a way that seating surfaces are prevented from contacting until near the point of closure. Valves 2" and smaller shall be bronze body screw in bonnet, non rising stem, inside screw, with threaded or solder end to suit service. Valves 2-1/2" and larger shall be flanged, and unless otherwise specified shall be bolted bonnet, non rising stem, cast iron body, bronze trim and replaceable seats.

Class 150:

2" and smaller - 150 psi steam, 300 psi W.O.G.

	Jenkins Bros.
Threaded	Fig. 370
Soldered	Fig. 1240

2-1/2" and larger - 125 psi steam, 200 psi W.O.G.

Flanged	Fig. 326

C. Globe Valves:

1. Globe valves 2" and smaller shall be bronze body and trim, threaded or solder end, to suit service. Globe valves 2-1/2" and larger shall be flanged, bolted bonnet, regrind renew bronze disc and seat ring, unless otherwise specified. Where composition discs are used the disc shall be suitable for the intended service.

Class 150:

2" and smaller - 150 psi steam, 300 psi W.O.G.

	Jenkins Bros.
Threaded	Fig. 106-A
Soldered	Fig. 1200

2-1/2" and larger - 125 psi steam, 200 psi W.O.G.

Flanged	Fig. 613

D. Check Valves:

1. Unless a composition disc is specified, swing check valves 2" and smaller shall be bronze body and trim, regrinding, with seating angle 40 to 45 degrees. A stop plug is required as a renewable stop for the hanger, unless otherwise specified. Disc and hanger shall be separate parts, and the disc shall be free to rotate. Hanger pins shall be supported on both ends by removable side plugs, and have a screw in cap.

2. Check valves 2-1/2" and larger shall be iron body, bronze trim, flanged, swing type, bolted cover, regrind renew bronze disc and seat ring. Disc and hanger shall be separate parts, and the disc shall be free to rotate. Hanger pins shall be supported on both ends by removable side plugs.

Class 150:

2" and smaller - 150 psi steam, 300 psi W.O.G.

Jenkins Bros.

Threaded	Fig. 92-A
Soldered	Fig. 1222

2-1/2" and larger - 125 psi steam, 200 psi W.O.G.

Flanged	Fig. 624

E. Drain Valves:

1. Drain valves shall be 3/4" size, 300 psi W.O.G. bronze body, with 3/4" hose outlet, National Standard threads, with bronze cap and chain attached.

   Jenkins Bros. Fig. 113 N Globe, Fig. 372 N Gate.

F. Standpipe and Sprinkler System Valves:

1. Shut-off valves shall be located in conveniently accessible positions and shall be of the OS & Y gate type.

2. Shut-off valves 4 inches and larger shall have the word "open" cast on the valve as well as an arrow to indicate which direction the valve shall be turned. The name of the maker and the guaranteed working pressure shall be stamped on each valve.

3. Valves 2 inches and smaller shall be screwed-end ball valves equal to Worcester Miser three-piece steel body, stainless steel ball and stem, TFE seats, lever handle, color coded, rated for one hundred seventy-five pound working pressure and conform to Factory Mutual and Underwriters' Associations' specifications.

4. Valves 2-1/2 inches and larger unless otherwise specified herein shall be OS & Y gate valves, equal to Kennedy Fig. 67 with screwed ends for valves smaller than 4 inches and Fig. 68 for valves 4 inches and larger, Underwriters' approved, for one hundred seventy-five pound WOG working pressure.

5. The valves shall have rough body with bronze finished trimmings.

6. Check valves shall be provided where specified or indicated on the drawings and in accordance with NFPA pamphlets No. 13, 14 and 20. Check valves shall be Underwriters' approved horizontal swing type with cast iron bodies bronze seat and disc and shall have the name of the maker and the guaranteed working pressure stamped or cast on valve body. Valves shall be rated for a working pressure of one hundred seventy-five pounds per square inch gauge and shall be tested to a pressure of three hundred pounds per square inch gauge. Check valves in the piping from the exterior fire department connections shall be provided with an Underwriters' approved 3/4 inch ball drip,

pipe to the sprinkler system drain. Kennedy UL listed, FM approved, wafer type with stainless steel hinge pin and spring, Buna-N, O rings and seal or approved equal.

G. Gas System Valves:

1. Valves - 3 inches and smaller unless otherwise specified herein shall be semi-steel tapered, teflon coated, lubricated plug valves, screw gland type, 200 pound WOG working pressure, 400 pound test, threaded ends and wrench operated, Rockwell Nordstrom Fig. 114, or approved equal.

2. Valves - 4 inches and larger shall be semi-steel tapered, teflon coated, lubricated plug valves, bolted gland type 200 pound WOG working pressure, 400 pound test, flanged ends and wrench operated, Rockwell Fig. 143, or approved equal.

3. Each shut-off valve shall be provided with the manufacturers standard size wrench for that particular valve installed.

H. Sundries:

1. Vacuum breakers shall be full size and equal to Watts Regulator Company No. 288A vacuum breaker. Hose bibb vacuum breakers equal to Watts No. 8A.

2. Trap primers shall be equal to Josam Series 88250.

3. Hose bibbs shall be equal to the following:

Type 1 (Toilet Rooms) Chicago NO. 952 (1/2")
Type 2 (Mechanical Rooms) Chicago No. 998 (3/4")

4. Reduced pressure backflow preventor shall be equal to Watts Series 909S with strainer, sizes as shown on drawings and Commonwealth of Massachusetts approved.

5. Shock Absorbers shall be equal to Josam series #1485 Absorbatron installed where indicated and in accordance with "Standard P.D.I. - WH201".

2.04 DRAINS - FLOOR AND ROOF

A. Manufacturer's catalog numbers specified herein for drains are intended only as a guide for the type and quality to be furnished and provided (floor drains) by this Contractor. Refer to drawings for sizes.

1. Floor drain, Type A, (Mechanical Rooms) shall be equal to Josam 32110-7 floor drain with nonpuncturing flashing collar and ductile iron grate.

2. Floor drain, Type B, (Trash Room) shall be equal to Josam Series 36000-7 with sediment bucket and ductile iron grate.

3. Roof drain, Type A, shall be equal to Josam 22004-3 coated cast iron roof drain with locking dome, nonpuncturing clamp ring with integral gravel stop, medium sump with anchor lugs, roof flange and bottom outlet.

4. Roof drain, Type B, shall be equal to Josam 24710-3 coated cast iron roof drain removable sloping bronze grate, flashing clamp, shallow sump with flashing flange and 45° side outlet threaded connection.

2.05 HANGERS AND ACCESSORIES

A. Carpenter Patterson Catalog numbers specified herein are intended only as a guide for the type and quality to be provided.

B. Friction clamps shall be equal to Figures 126 or 126 CT for iron, steel or copper pipe.

C. Clevis type hanger shall be equal to Figures 100 or 100 CT for iron, steel or copper.

D. Hangers for uncovered (uninsulated) copper and brass piping shall be factory applied copper plated steel Clevis hangers, Fig. 100 CT, rods and nuts used with these hangers shall also be factory applied copper plated.

E. Where three or more pipes are running parallel to each other, factory fabricated gang type hangers with pipe saddle clips or rollers may be used in lieu of the hereinbefore specified Clevis hangers. These hangers shall be sized to provide for insulation protectors as hereinafter specfied. Pipe saddle clips shall be not less than 16 gauge metal and shall be copper when installed with uninsulated copper or brass piping, insulation protectors shall be provided at each set of rollers and filled with a section of heavy density fiberglass pipe covering specified hereinafter. (Refer to Paragraph 2.07). Fig. 342 sized to suit loading with hanger rods and nuts.

F. Extension type split ring hangers with wall plates shall be equal to Figures 81, 81 CT, 90, 90 CT and 85, 85 CT plates for iron, steel and copper respectively.

G. All horizontal piping shall be suspended from the building by mild steel rod connecting the pipe hanger to inserts, beam clamps, and angle brackets as required by the building construction in accordance with thhe following:

Pipe Size In Inches	3/4 to 2	2-1/2 to 3-1/2	4 to 5	6	8 to 12
Rod Diameter In Inches	3/8	1/2	5/8	3/4	7/8

H. Hanger rods for other installations shall be sized in accordance with the recommended load capacities of ASTM Specifications Designation A-107, latest amendment.

I. Insulation protectors (shields) for horizontal piping shall be constructed of galvanized steel formed to a 180 degree arc and 12 inches long, equal to Figure 265P, 18 gauge type H for hangers 5 inches in size and smaller, 16 gauge for hangers larger than 5 inches in size.

J. Exposed rods, clamps and hangers in finished areas shall be electrogalvanized coated.

K. Refer to Part 3, "GENERAL INSTALLATION REQUIREMENT" for piping installations belowground.

2.06 SLEEVES, INSERTS AND ESCUTCHEONS

A. All pipes passing through floors, walls, or partitions shall be provided with sleeves having an internal diameter one inch larger than the outside diameter of the pipe or insulation on covered lines.

B. Sleeves through outside walls shall be Schedule 40 black steel pipe with a 150 pound black steel slip on welding flanges, welded at the center of the sleeve and shall be painted with one coat of bitumastic paint, inside and outside.

C. Sleeves through masonry floors and interior masonry walls shall be Schedule 40 black steel pipe.

D. Sleeves through outside walls shall be provided with pipe to wall penetration closures equal to Link-Seal Thunderline Corporation. Seals shall be mechanical type of interlocking rubber links shaped to fill space between pipe and sleeve. Links shall be assembled with bolts to form a belt around the pipe with pressure plate under each bolt head and nut. After seal assembly is positioned, tightening of bolts will provide watertight seal. This Contractor shall determine the required inside diameter of each individual sleeve before ordering, fabricating or installing. The inside diameter of each sleeve shall be sized as recommended by the manufacturer to fit the pipe and Link-Seal to assure a watertight joint.

E. Sleeves through interior non-masonry walls or partitions shall be 22 gauge galvanized sheet steel.

F. Inserts shall be individual or strip type of pressed steel construction with accommodation for removable nuts and threaded rods up to 3/4 inch diameter, permitting lateral adjustment. Individual inserts shall have an opening at the top to allow reinforcing rods up to 1/2 inch diameter to be passed through the insert body. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods.

G. Unless otherwise specified herein, escutcheons shall be cast brass chrome plated type and provided with a set screw to properly hold escutcheon in place.

2.07 PIPE COVERING

A. General: Pipe covering specified herein for piping systems shall be provided in strict accordance with the manufacturer's printed instructions, the best practice of the trade and to the full intent of this Specification.

1. All sealers, tapes, adhesives and mastics used in conjuction with the installation of the pipe covering specified herein shall possess the maximum possible fire-safe qualities available and shall be of a type approved by Factory Mutual, Factory Insurance Association or National Fire Protection Association.

2. Valves, fittings, flanges and accessories shall have the same thickness of pipe covering applied as the adjacent pipe. Pipe covering for these items shall be factory molded type Zeston or approved equal.

3. Where mineral cement is installed on roof drain bodies the thickness shall be equal to the covering on the adjoining pipe. The cement shall be neatly troweled on. Over the cement, furnish and install a fire retardant glass cloth jacket, which shall be embedded in a fire retardant vapor-proof adhesive with a three inch minimum overlap at the seams. The glass cloth jacket shall be smoothed out during the application to avoid wrinkles and gaps.

4. Field applied glass cloth jacket shall be finished with a fire resistant coating having a vapor transmission of not more than 1.0 perm.

5. Longitudinal seams and four inch wide end joints sealing strips shall be sealed with a fire retardant, vapor barrier adhesive.

6. Provide at each pipe hanger and/or pipe support on covered lines a section of heavy density (7.5 pounds per cubic foot) fiberglass sectional pipe covering in lieu of the fiberglass covering specified herein. The inserted section at each hanger (including sheet-metal saddles) shall be of the same thickness as the adjacent pipe covering and finished as specified herein for fittings.

B. Interior Cold Water, and Hot Water Piping:

1. All interior cold water, hot water, and hot water return piping shall be covered with one inch thick fiberglass covering as specified herein for interior storm drainage piping.

Exposed water piping shall be provided with an additional field applied glass mesh cloth jacket and sealed as specified herein. Insulation shall be continuous through sleeves.

2. Ends of insulation at termination points and at pipe supports shall be sealed to the pipe with a brush coat of vapor barrier coating.

2.08 FIRE PUMP SYSTEM (TWO REQUIRED)

A. General:

1. Provide where indicated; Underwriters' Laboratories, Inc. listed and Associated Factory Mutual Fire Insurance Companies two fully approved (where applicable) fire pump systems complete with pumps, driver,s controllers, accessories, jockey pumps and controls. Systems shall be an Peerless Fire Pump System or equal and meet all the requirements of NFPA Pamphlet No. 20.

B. Fire Pump:

1. Pump shall be designed to deliver 750 GPM when operating at 150 PSIG.

2. Pump shall also deliver not less than 150 percent of rated capacity at a pressure not less than 65 percent of rated pressure.

3. Shut off pressure shall not exceed 120 percent of rated pressure. Suction pressure is 50 PSIG.

4. Pump shall operate at a maximum synchronous speed of 3450 RPM maximum.

5. Pump shall be Peerless Model 4ABF10 or approved equal, horizontal base mounted pump.

6. Driver shall be vertical, 50 HP open dripproof, ball bearing type, AC, induction, squirrel cage motor; wound for 208 volts, 3 phase, 60 hertz. Motor shall be of such capacity that 115 percent of the full-load ampere rating shall not be exceeded at any condition of pump load for UL Listed Fire Pump Systems and 110 percent for FM Approved Fire Pump Systems. Locked rotor current shall not exceed the values specified in NFPA Pamphlet No. 20. Motor shall be at least 12 inches off floor when installed.

7. Pump and motor shall be mounted on a common baseplate constructed of steel with drip rim.

8. Pump and motor shall be checked for alignment after the pump base has been installed and grouted in place.

9. Pump Construction

a. Casings shall be of cast iron having a minimum tensile strength of 35,000 PSI. Bearing housing supports, and suction and discharge flanges shall be integrally cast with lower half of the casing. Removal of the upper half of the casing must allow the rotating element to be removed without disconnecting the suction and discharge flanges.

b. Impellers shall be of the enclosed type and shall be of vacuum cast bronze, dynamically balanced, keyed to the shaft, and held in place with threaded shaft sleeves.

c. Pump shaft shall be made of SAE 1045 Steel or equal, accurately machined to give a true running rotating element. Shaft shall be protected by bronze sleeves which are key locked and threaded so that the sleeves tighten with rotation of the shaft. A gasket shall seal between the impeller hub and the shaft sleeve to protect the pump shaft.

d. Pump shall be equipped with renewable bronze casing rings so designed that hydraulic pressure will seat them against a shoulder in the pump case around the full periphery of the wearing ring. The wearing rings will be locked by dowelling to prevent rotation. The rotating element uses heavy duty grease lubricated ball bearings and shall be equipped with water slingers. Bearing housings shall be so designed to flush lubricant through the bearing.

e. Pump shall be provided with a lantern ring connected to the pressure side of the pump by a cored passage in the parting flange of the pump. Stuffing boxes shall be equipped with split bronze packing glands designed for easy removal for packing inspection and maintenance.

C. Accessories:

1. Provide the following accessories to conform with NFPA Standards:

a. One (1) eccentric tapered suction reducer.

b. One (1) concentric tapered discharge increaser.

c. One (1) hose valve header with 6 connections.

d. Four (4) 2-1/2 inch hose valves with caps and chains.

e. Two (2) pressure gauges one each in suction and discharge sides of pump.

f. One (1) automatic air release valve.

g. One (1) circulation relief valve.

h. One (1) ball drip valve.

i. One (1) coupling guard.

j. One (1) casing relief valve.

D. Fire Pump Controller:

1. Provide a UL labelled and FM approved fire pump controller which shall be completely assembled, wired and tested at the factory and the assembly shall be specifically approved for fire pump control.

2. Controller shall be factory labeled "Fire Pump Controller".

3. Controller shall be located as close as practical and within sight of the motor, but protected so that it will not be injured by water escaping from the pump or piping connections.

4. Controller shall be an approved drip-tight single enclosure of the combined manual and automatic reduced voltage type starter, complete with the following:

a. Disconnect switch - externally operable, quick break type.

b. Circuit breaker - time delay type with trips in all phases set for 300 percent of the motor full load current. Interrupting capacity of circuit breaker shall be asymmetrical amperes.

c. Running period timer - set to keep motor in operation, when started automatically, for a period of one minute for each 10 HP motor rating, but not to exceed 7 minutes.

d. Pilot lamp - to indicate circuit breaker closed and power available.

e. Ammeter test link and voltmeter test studs.

f. Alarm relay - to energize an audible or visible alarm through an independant source of power to indicate circuit breaker open on power failure.

g. Manual selection station - two position station shall be provided on the enclosure marked "AUTOMATIC" and "NON-AUTOMATIC".

h. Contacts for remote alarm of: Controller in "Pump Running" condition, loss of line power in any phase, control transformer failure or disconnection.

E. Tests:

1. Pump, motor and control panel shall be tested as one unit.

2. Pump with its driver shall be given a complete performance test with POSITIVE PRESSURE. Pumps shall be hydrostatically tested to twice the shut-off pressure, but in no case less than 250 PSIG.

3. Certified pump characteristic curves prepared from the test results shall be furnished to the Architect prior to final acceptance.

F. Jockey Pump and Control:

1. Provide an approved equal vertical multi-stage centrifugal type pump with cast iron casing, integral relief valve, bronze trim and mechanical sealed stuffing boxes.

2. Pump shall have a capacity of 8 GPM at 220 feet.

3. Pump shall be driven by 1/2 HP, 3 phase, 60 hertz, 208 volt, open dripproof motor.

4. For control of pump, provide an adjustable mercury tube pressure switch, fusible disconnect switch, a magnetic across-the-line starter, a selector switch and a minimum running period timer, all in a single NEMA 1 enclosure.

G. Alarm Panel:

1. Provide an alarm panel for mounting in Office "B". Panel shall operate on 115 volt, 60 hertz power for supervisory voltage. Panel shall be provided with contacts and visual-audible alarm signals for "pump running" condition, loss of line power in any phase and control transformer failure or disconnection.

H. Startup, operating and maintenance instructions shall be provided, refer to paragraphs 3.03 and 3.04.

I. Wiring to fire pump controller, fire pump, jockey pump controller, jockey pump, alarm panel and interconnections with fire alarm system to be provided under Division 16.

2.09 CLEANOUTS

A. Bodies of cleanout ferrules in hub and spigot or no-hub piping shall be standard pipe size conforming in thickness to that required for pipe and fittings; and shall extend not less than 3/4 inch above the hub of the pipe. The cleanout plug shall be of cast brass and shall be provided with a raised nut 3/4 inch high. Cleanouts in copper waste piping shall be soldered cast brass cleanout fit-

tings with extra heavy brass screw plugs of the same size as the pipe line. Cleanouts in threaded waste piping shall be cast iron drainage "T" pattern 90 degree branch fittings with extra heavy brass screw plugs of the same size as the pipe.

B. Floor cleanouts in finished areas shall be equal to Josam Series #56010 with nikaloy top.

C. Floor cleanouts in unfinished areas (mechanical rooms and storage rooms) shall be equal to Josam Series 56050 with cast iron top.

D. Wall cleanouts shall be equal to Josam Series 58640 with nikaloy access frame having anchor lugs and satin finish secured cover.

2.10 PLUMBING FIXTURES

A. Manufacturer's plumbing fixture (including accessories) catalog numbers specified herein are intended only as a guide for the type and quality to be provided by this Contractor. Colors to be selected by Architect.

B. Water Closet (P-1) — Kohler K-3420-EB Wellworth "Lite" vitreous china close-coupled siphon jet elongated toilet complete with two (2) K-4561 bolt caps, K-4652 seat and K-7638 3/8" angle supply.

C. Water Closet (P-1A) — Kohler K-3527-EB Highline vitreious china close-coupled siphon jet elongated toilet complete with two (2) K-4561 bolt caps, K-4652 seat and K-7634 3/8" angle supply.

D. Lavatory (P-2) — Kohler K-2195 Pennington self-rimming vitreous china oval lavatory with K-7401-DB faucet, K-7606 3/8" angle supplies with stops and K-9000 1-1/4" cast brass P-trap.

E. Lavatory (P-2A) (Handiapped) — Kohler K-12636 Morningside vitreous china wall hung lavatory complete with K-13335 faucet, K-13711 angle supplies with stops and offset P-trap and chair carrier to suit.

F. Bath Tub (P-3) — Kohler K-505-S Mendota enameled cast iron bath with Safeguard bottom (left or right outlet), K-7160-R pop-up drain and Symmons S-96-2X tub and shower valve assembly.

G. Bath Tub (P-3A) (Handicapped) — Same as P-3, except modified with Symmons S-96-400-V-B24 tub and shower valve assembly.

H. Kitchen Sink (P-4) — Just SL-2125-B-GR 4-hole, stainless steel sink with in-sink-erator Model #333 garbage disposal and Symmons S-93-2 faucet and spray.

I.	Kitchen Sink (P-4A) (Handicapped)	Same as P-4, except modified with offset P-trap, J-35 strainer for handicap (less disposal).
J.	Washer Machine (P-5) (Handicapped)	Guy Gray #BED-200 with duplex electric grounding receptacle and dryer outlet.

2.11 HOT WATER HEATERS

A. Hot water heater for Parcel 29-A shall be equal to PVI Industries 500-P-125A-TP natural gas turbo-powered water heater which shall fire 400,000 BTUH and contain 125 gallons of stored water. The unit shall recover 500 GPH at an 80°F temperature rise.

B. Hot water heater for Parcel SE-70/SE-71 shall be equal to PVI Industries 375-P-125-A-TP natural gas turbo-powered water heater which shall fire 300,000 BTUH and contain 125 gallons of stored water. The unit shall recover 375 GPH at an 80°F temperature rise.

C. Each heater shall have the following:

1. ASME temperature and pressure relief valve, temperature limiting device, drain valve, temperature and pressure gauges, low water cut-off, second main gas valve, shall be factory installed.

2. Controls shall be electronic flame monitoring systems 115V external power required upper and lower electrically operated thermostats, automatic reset temperature limiting device, electrically operated main gas valve, pressure regulator, manual gas shut-off valve, flame with shut down of pilot and main burner gas supply within 2-4 seconds if loss of pilot should occur.

3. The water heater shall include all standard equipment, shall carry a five (5) year warranty and shall meet all state and local codes.

2.12 GAUGES AND THERMOMETERS

A. Pressure Gauges:

1. Gauges shall be installed with suitable "T" handle gauge cocks to permit servicing. Unless otherwise specified herein, all guages shall be 5 inch diameter, dial type, stainless steel case with back flange, aluminum peaked ring, phospher bronze, bourdon tube, 1/4 inch forged brass N.P.T. male socket connection with wrench flats, white lithographed steel dial with black numbers and graduation. Dial graduations reading in "PSIG" shall be such that the normal operating pressure will be indicated near the middle of the scale.

2. All pressure gauges installed 8 feet or higher above the finished floor shall have 6 inch diameter dial face, unless otherwise specified herein.

B. Thermometers:

1. Thermometers shall be hermetically sealed, bimetal, dial thermometers with stainless steel cases, anti-paralox dials with raised jet black figures, stainless steel stems and brass separable sockets. Thermometers shall be vapor or mercury actuated with separable wells. Thermometers shall be graduated to "degrees F" and shall have a range so that the normal operating temperature will be in the middle of the scale.

2. The face diameter of dials on thermometers installed within 8 feet of the finished floor shall be not less than 4-1/2 inches; all other thermometers installed above 8 feet from the finished floor shall be not less than 6 inches.

C. Gauges and thermometers shall be as manufactured by U.S. Gauge or approved equal.

D. The accuracy of all gauges and thermometers shall be within one (1) percent of the scale range.

2.13 SPRINKLER AND STANDPIPE ACCESSORIES

A. Fire standpipe system accessories shall be as manufactured by Croker-Standard Division, Fire-End and Crocker Corp. W.D. Allen Manufacturing or approved equal manufacturer. The following Croker items are intended only as a guide, for the type and quality to be installed by this Contractor.

1. Class I Fire Department valves shall be equal to Underwriters' approved No. 157, 2-1/2 inch 300 pound chrome plated polished brass angle valves with red enameled iron wheel handle, No. 256, 2-1/2 inch restrictor, and No. 4051 satin brass reducer 2-1/2 by 1-1/2 inch, No. 126 chrome plated brass polished cap with chain, and two No. 2215 common spanner wrenches. Threads on each valve outlet shall conform to the local fire department standards.

2. Fire Department connections for the combined system shall be cast brass equal to No. 367 three-way 4 inch by 2-1/2 by 2-1/2 inch concealed siamese with three No. 1127 threaded plugs and chains, plate branded "STANDPIPE-SPRINKLER" and having a chrome plated polished finish. Threads shall conform to the local fire department's requirements.

B. Sprinkler Heads:

1. Sprinkler heads as manufactured by Reliable, Grinnell, or Automatic Sprinkler Corp. shall be installed in accordance with architectural reflected ceilings in all finished areas.

2. Automatic Sprinklers: Sprinklers, in general, shall be automatic - close type with a 1/2 inch nominal size orifice. Unless otherwise indicated on the drawings, temperature rating of fusible elements shall be in accordance with NFPA No. 13. Automatic sprinklers of standard temperature rating (165 degrees Fahrenheit) shall be used except in areas indicated on the drawings where above normal temperatures, will occur. In such areas high temperature sprinklers (212 degrees Fahrenheit) shall be provided.

3. In all open areas where electrical equipment is located, each sprinkler head shall be equipped with approved type shield to keep water off the electrical equipment.

4. Areas without a hung ceiling shall be brass, upright Reliable Model "G" or equal.

5. Finished areas (apartments) without hung ceilings shall be chrome plated brass sidewall type equal to Reliable Model D.

6. Areas with hung ceiling, pendent, flush, chrome plated head and escutcheon plate Reliable Model "G1" or equal.

C. Spare Sprinkler Heads and Cabinet:

1. Provide where directed by the Architect, a metal cabinet in the building containing spare sprinkler heads and wrenches.

2. Cabinet shall have shelves for storing the spare sprinkler heads in an orderly manner. The shelf spaces shall be sub-divided to segregate the sprinkler heads of each type and clearly identify them with approved markings. Cabinet shall have proper arrangements for hanging the wrenches. Wrenches shall be located so as to be readily accessible.

3. Cabinet shall be dust tight and red in color, enameled finish. The outside of the cabinet door shall have painted on it in legible and clear lettering "Automatic Sprinklers - Reserve Supply", suitable standard instructions pertaining to the sprinkler systems and any other necessary information shall be fastened onto the inside of the cabinet door.

4. The cabinet size and number of each type spare sprinkler heads shall conform to the National Fire Protection Association Pamphlet No. 13.

D. Water Pressure Gauges:

1. Water pressure gauges of the double spring Bourdon type, as manufactured by U.S. Gauge, American, Mueller, Trerice, Ashcroft or approved equal, shall be installed in the sprinkler system. The gauges shall have a 6 inch diameter face with brass case and shall be Underwriters' approved.

2. Gauges shall be controlled by a valve with arrangements for drainage. An outlet, at least one quarter of an inch in size, plugged for the installation of the inspector's gauge shall be located between each valve and gauge.

3. Dial graduations reading in "psig" shall be such that the normal operating pressure of the system installed shall be indicated near the middle of the scale.

4. The accuracy of the gauges shall be within one (1) percent of the scale range.

E. Zone Alarms:

1. All sprinkler system branches on each floor supplied from the combination standpipe-sprinkler risers shall be provided by the Contractor with UL approved flow switches containing the proper contacts to be wired to the fire alarm system. Connect each flow switch to the zone module of the fire alarm system for the respective floor. Gamewell - Vane type - Model 9304 or approved equal. Wiring of each flow switch to fire alarm control panel to be provided under Division 16.

F. Control Valve Monitor Switches:

1. Provide with each OS & Y gate valve in the combination sprinkler/standpipe system a tamper proof monitor switch equivalent to Automatic S-1110-104. (N.O.) Wiring of each monitor switch to fire alarm control panel to be provided under Division 16.

G. Sundries:

1. Sundries used in connection with brass work shall be of brass with matching finish. Sundries used in connection with galvanized iron work shall be galvanized.

H. Transmitting Equipment:

1. Transmitting equipment provided under this Section of the specification for alarm valve and tamper switch alarms located in fire alarm central panel (Division 16) must be compatible in all respects with aforementioned fire alarm supervisory control system. Refer to Division 16 for requirements before purchasing transmitting equipment as herein specified for fire protection equipment.

I. Electric Alarms:

1. Electric bells shall be provided locally (sprinkler rooms) and remotely on exterior walls.

2. Contractor shall obtain Architect's approval of exterior alarm bell locations prior to installation.

3. Wiring of electric bells (interior and exterior) to be provided under Division 16.

2.14 HOT WATER CIRCULATING PUMP

A. Provide where indicated a hot water circulating pump equal to the Bell and Gossett Company "In-Line" one inch HV all bronze circulating pump with bronze impellers.

B. Control of the pump shall be by means of an immersion aquastat with visible scale and detachable well which shall be installed in the recirculating line and shall be so designed and connected that when the water temperature in the recirculating line drops to 115 degrees F, the pump shall start and when the temperature reaches 135 degrees F, the motor shall stop. The aquastat shall be guaranteed to operate within a maximum range of plus or minus 2 degrees F of the setting. The aquastat electrical contacts shall be rated 20 ampere, 120 volt.

C. Wiring of pumps and aquastats will be performed under another Division 16.

2.15 EXPANSION JOINTS, ANCHORS AND GUIDES

A. Expansion Joints:

1. Expansion joints in copper lines shall be equal to Flexonics Model HB all bronze expansion compensator, with bronze bellows, brass shrouds and end fittings, non ferrous internal parts and designed where service pressure is external to the bellows.

a. Compensators shall have internal guides extending the full length of the bellows travel, internal positive anti-torque on installation, properly located positioning clip to insure installation at correct end-to-end dimension to allow full rated traverse.

b. Compensators shall be designed for a total stroke of 2 inches (1-3/4 inch compression and 1/4 inch extension), 406 degrees F maximum operating temperature, 150 PSIG maximum test pressure.

B. Pipe Anchors:

1. Pipe anchors shall be equal to Flexonics Factory fabricated anchor pipe coupling for copper tubing.

C. Pipe Guides:

1. Pipe guides shall be equal to Flexonics Figure 1 modified pipe alignment guides with steel shell, mounting legs, steel spider with copper shims to insulate the steel spider from the copper pipe or tubing.

2. Pipe guides shall be installed on each side of the expansion joint or loop as follows:

   a. First - 4 pipe diameters from expansion joint or loop.

   b. Second - 14 pipe diameters from first pipe guide.

   c. Third, fourth or fifth if required.

      1) 20 feet on centers for one inch and 1-1/4 pipe sizes.

      2) 25 feet on centers for 1-1/2 inch and 2 inch pipe sizes.

      3) 35 feet on centers for 2-1/2 inch and larger pipe sizes.

2.16 WATER METER

A. Provide where indicated a water meters and bypass of the type and make approved by the City of Boston, Massachusetts Water and Sewer Departments.

B. Provide a pressure gauge on the discharge side of the meter and continue the cold water distribution system throughout the building as specified.

C. Provide a shut-off valve inside the foundation wall (inlet to meter) and on the discharge side of the meter.

2.17 BACKWATER VALVE

A. Valve shall be equal to Josam Series 67350-29 coated cast iron combination backwater valve, straight-through type, bronze swing-check assembly, bronze manually operated shear-gate with non-rising stem, hub connections, extension and stem to finished grade.

PART 3 - EXECUTION

3.01 IDENTIFICATION

A. All equipment and each length of pipe, each pipe fitting, trap, fixture, control panel, starter and device used in the systems shall have a permanently attached nameplate or be cast, stamped or indelibly marked with the manufacturer's mark or name, the weight, type and class. Nameplates shall be kept clean and readable at all time.

B. Piping:

1. Furnish and affix approved adhesive bands identifying the service and direction of flow of each piping system installed under this Section of the Specifications.

2. Identification shall be provided on all piping that is exposed as well as all in concealed locations such as shafts, and above removable ceilings in which piping may be viewed.

3. Each set shall consist of one band on which the name of the service is printed and one band on which is printed a black directional arrow.

4. Bands shall be applied where they can be easily read from the finished floor below, with their long dimension parallel to the axis of the pipe.

5. Bands shall be applied only after finish painting is completed.

6. In general, the piping of each system shall be identified in the following locations and the piping designation shall be taken from the legend as indicated on the drawings.

a. Pipe mains and branches - every 25 feet in all accessible area's and 10 feet apart in congested areas.

b. At each side of each valve and pipe tees.

c. Each wall penetration (both sides).

d. Each riser including branch risers from mains.

e. At each piece of equipment.

C. Equipment:

1. Each item of equipment including controls, not provided with a manufacturer's nameplate shall be identified by this Contractor with a permanently attached nameplate.

2. Equipment marking shall be prominently located on each normally visible side of equipment. Equipment intended for instal-

lation in finished areas shall have markings located behind normally used access panels mounted so as to be readily found.

3. Nameplates, catalog numbers and rating identification shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

D. Valve Tags:

1. Valve numbers on valve tags shall correspond to numbers indicated on the Record Drawings.

E. Valve Charts and Lists:

1. Provide to the Owner through the Architect, two, printed detailed valve number lists. These printed lists shall state the numbers and location of each valve and the fixture or group of fixtures which it controls, and other necessary information, such as requiring the opening or closing of another valve or valves, when any one valve is to be opened and closed.

2. These printed lists shall be prepared in form to meet approval of the Architect and shall be framed under glass.

3.02 TESTING

A. General:

1. All labor, materials, instruments, devices and power required for testing shall be provided by this Contractor. The tests shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction. No piping in any location shall be closed up, furred in, or covered before testing.

2. Where portions of piping systems are to be covered or concealed before completion of the project, those portions shall be tested separately in the manner specified herein for the respective entire system.

3. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Architect shall be retested in part or in whole as directed.

4. The Architect retains the right to request a recheck or resetting of any pump or instrument by this Contractor during the guarantee period at no additional cost to the Contract.

5. Repair, or if directed by the Architect, replace any defective work with new work without extra charge to the Contract. Repeat tests as directed, until the work is proved to meet the requirements specified herein.

6. Restore to its finished condition any work, provided by other Contractors, damaged or disturbed by this Contractor's tests. This Contractor shall engage the original Contractor to do the work of restoration to the damaged or disturbed work.

7. The fixtures shall be tested for stability of support and satisfactory operation. Fixture piping shall be tested when directed by the Architect for stability of support.

8. After the fixtures are set and connected, and the piping systems to same have been tested, this Contractor shall turn water on to the fixtures, equipment, fill the traps, etc., and the proper operation of all items shall be demonstrated by him in the presence of and to the satisfaction of the Architect or his designated representatives.

9. Caulking of screwed joints or holes in piping will not be acceptable.

10. This Contractor shall notify the Architect and his inspectors having jurisdiction, a minimum of 48 hours in advance of making any required tests so that arrangements may be made for their presence to witness his scheduled tests.

B. Specific:

1. Sanitary Piping Systems

a. Before the installation of fixtures, equipment and insulation, each system including vents shall have all necessary openings plugged to permit the entire system to be filled with water to the level of the vent stack or roof drain of each system above the roof where practical. Each system shall hold this water for four hours without a drop in water level.

b. Where a portion of the system is to be tested, the test shall be conducted in the same manner as specified herein for the entire system, except a vertical stack ten feet above the highest horizontal line to be tested may be installed, and filled with water to maintain sufficient pressure. A pump may be used to supply the required pressure. The pressure shall be maintained for a minimum of four hours or sufficient time to permit inspection for all joints.

2. Cold, Hot and Hot Water Return Piping Systems

a. Upon completion of the roughing-in and before setting fixtures and final connections to all equipment, all water piping systems shall be tested to a hydrostatic pressure of 150 pounds per square inch gauge.

b. Each systems test shall be maintained for eight hours without a drop in pressure.

c. After testing, provide complete adjustment of all parts of each water system until design distribution or balancing is obtained throughout.

3. Combined Sprinkler/Standpipe System

a. The complete testing procedure for standpipe and each sprinkler system shall be in accordance with the requirements stated in the National Fire Protection Association Pamphlets No. 13, 14, and 20, but not less than the procedures specified herein.

b. In general, the combined standpipe-sprinkler systems shall be tested with water to a hydrostatic pressure of 225 pounds per square inch gauge. This pressure shall be maintained for a minimum of four (4) hours or until the systems have been inspected for leaks and defects.

4. Gas Systems

a. Before any system of gas piping is finally put into service, piping shall be carefully tested in the presence of, and with the approval of, the gas inspector to insure the system is gas tight.

b. To test for tightness, piping may be filled with the system designed fuel gas, compressed air or inert gas, but not with any other gas or liquid. OXYGEN SHALL NEVER BE USED FOR TESTING.

c. Piping systems, extending from the discharge side of the gas meter set assembly to the closed shut-off valve at each piece of equipment and/or appliance shall be tested to a pressure of 3 PSIG for a period of one-half hour for each 500 cubic feet of pipe volume or fraction thereof.

d. Pressure shall be measured with a mercury manometer or an equivalant approved device, so calibrated as to be read in increments of not greater than one-tenth pound. The source of pressure shall be isolated before the pressure tests are made.

5. Exterior Water Piping

a. All newly installed underground water piping shall be subjected for 2 hours to a hydrostatic pressure test of 150 pounds per square inch. Joints showing visible defects (i.e. pipe, fittings, valves,) shall be replaced by this Contractor and the test shall be repeated until the test results are satisfactory to the Architect.

b. No piping installation will be accepted unless leakage (evaluated on a pressure basis of 150 pounds per square inch) is less than 1 U.S. gallon per 24 hours per 50 feet of pipe per inch; locate and repair the defective joints until the leakage is within the specified limits. Before the replacement of permanent paving and not less than 30 nor more than 40 days after the pressure test, the Architect retains the right to request a measured leakage test of the entire new pipe line installation at no additional cost to the Contract.

3.03 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Prior to completion of the Contract, provide field operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for the equipment and systems installed.

B. All equipment provided under this Section of the Specifications shall be placed in operation and shall function continuously in an operating test for a period of one week, without shut down due to mechanical failure or necessity of adjustment.

C. Prior to scheduling the project final inspection and after completion of the entire installation running test period, provide all work required to adjust all controls, hot water systems balancing and all maintenance to place the systems in operation to meet the requirements of this Section of the Specifications and Contract Documents.

D. During the aforementioned running test period, deliver, to the Owner through the Architect, six (6) complete sets of operating service, maintenance instruction manuals and replacement data for the equipment which will require operational maintenance or replacement and one copy of this literature shall be available during the instruction of the operating personnel while the others are checked for completeness by the Architect.

E. During the working hours of the aforementioned "one week operating test" this Contractor's instruction personnel shall be available for giving field instructions to the Owner's Operating and Maintenance Personnel. This field instruction shall cover operation, maintenance and adjustment of the equipment installed, to the complete satisfaction of the Owner.

F. Sufficient advance notice shall be given to the Owner designated operating personnel for the specified instruction period. Upon completion of instruction, obtain from such representative(s) written verification that the above mentioned instructions has been performed. Such verification shall be forwarded to the Owner through the Architect.

G. Each copy of the approved operating and maintenance manual shall contain copies of approved shop drawings, equipment literature,

cuts, bulletins, performance charts, pump curves, details, equipment and engineering data sheets and typewritten instructions relative to the care and maintenance for the operation of the equipment, all properly indexed and bound in its hard-back three ring binder. Flysheets shall be placed before instructions covering each section. The instruction sheets shall be 8-1/2 inches by 11 inches with large sheets of drawings folded in neatly. Each manual shall have the following minimum contents:

1. TABLE OF CONTENTS

2. Introduction

   a. Explanation of manual and its purpose and use.

   b. Description of the plumbing-fire protection systems.

   c. Description of motor controls.

   d. Description of sequence for start-up, operating and shutdown for domestic hot water supply and circulating system; domestic cold water booster system; fire pump system; dry pipe sprinkler systems; combined standpipe-sprinkler systems; and gas booster.

   e. Safety precautions necessary for equipment.

   f. Illustrations, schematics and diagrams.

   g. Wiring diagrams.

   h. Installation drawings.

3. Maintenance

   a. Maintenance and lubricating instructions.

   b. Replacement charts.

   c. Preventive maintenance recommendations.

   d. Trouble shooting charts for equipment components.

   e. Testing instructions for each typical component.

   f. System draining and filling instructions.

   g. Two typed sets of charts indicating equipment tag number, location of equipment, specific equipment service, greasing and lubricating requirements as recommended, lubricant type and intervals of lubrication. Two complete charges of lubricating oil necessary for all equipment shall be furnished.

h. Two typed sets of instructions for ordering spare parts. Each set shall include name, price, telephone number and address of where they may be obtained.

4. Manufacturer's Literature

a. The equipment for which shop drawings have been submitted and approved.

3.04 START-UP SERVICE

A. When the equipment listed herein has been completely piped up, wired and ready for operation, the Contractor shall contact the supplier's or manufacturer's authorized representative, who as soon thereafter as possible shall visit the project and place the equipment in operation, making such adjustments as may be necessary to provide satisfactory performance.

B. Before the following equipment is accepted, the Contractor shall furnish the Architect with a written statement from supplier or manufacturer's authorized representative indicating that the equipment was started up by them and was left in satisfactory manner.

1. Packaged hot water heaters and circulating pumps.

2. Fire pump, Jockey pump and controllers.

3.05 DISINFECTION, CLEANING AND ADJUSTING

A. Disinfection:

1. Each potable water system (cold, hot and hot water return) shall be cleaned and disinfected by this Contractor. Cleaning and disinfection shall be performed after all pipes, valves, fixtures and other components of the systems are installed, tested, and ready for operation.

2. All domestic hot and cold water piping shall be thoroughly flushed with clean potable water, prior to disinfection, to remove dirt and other contaminants. Screens of faucets shall be removed before flushing and reinstalled after completion of disinfection.

3. Disinfection shall be done using sodium hypochlorite in the following manner:

a. A service cock shall be provided and located at the water service entrance. The disinfecting agent shall be injected into and through the system from this cock only.

b. The disinfecting agent shall be injected by a proportioning pump or device through the service cock slowly and continuously at an even rate. During disinfection, flow

of disinfecting agent into main water supply is not permitted.

c. All sectional valves shall be opened during disinfection. All outlets shall be fully opened at least twice during injection and the residual checked with orthotolidin solution.

d. When the chlorine residual concentration, calculated on the volume of water the piping will contain, indicates not less than 50 ppm (parts per million) at all outlets, then all valves shall be closed and secured.

e. The residual chlorine shall be retained in the piping systems for a period of not less than 24 hours.

f. After the retention, the residual shall be not less than five parts per million. If less, then the process shall be repeated as described above.

g. If satisfactory, then all fixtures shall be flushed with clean potable water until residual chlorine by orthotolidin tests shall be not greater than the incoming water supply (this may be zero).

4. All work and certification of performance shall be performed by approved applicators or qualified personnel with chemical and laboratory experience. Certification of performance shall indicate:

a. Name and location of the job and date when disinfection was performed.

b. Material used for disinfection.

c. Retention period of disinfectant in piping system.

d. PPM chlorine during retention.

e. PPM chlorine after flushing.

f. Statement that disinfection was performed as specified.

g. Signature and address of company/person performing disinfection.

5. Upon completion of final flushing (after retention period) this Contractor shall obtain a minimum of one water sample from each hot and cold water line and submit samples to a State-approved laboratory, Samples shall be taken from faucets located at highest floor and furthest from meter or main water supply. The laboratory report shall show the following:

a. Name and address of approved laboratory testing the samples.

b. Name and location of job and date the samples were obtained.

c. The coliform organism count. (An acceptable test shall show absence of coliform organisms.)

6. If analysis does not satisfy the above minimum requirements, the disinfection procedure shall be repeated.

7. Before acceptance of the systems, this Contractor shall submit to the Architect for his review, three (3) copies of Certification of Performance as specified above.

8. Under no circumstances shall this Contractor permit the use of any portion of domestic water systems until properly disinfected, flushed and certified.

B. Cleaning and Adjusting:

1. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge which may have accumulated by operation of the system for testing.

2. Any stoppage or discoloration or other damage to parts of the building, its finish, or furnishings, due to this Contractor's failure to properly clean the piping system shall be repaired by this Contractor at no increase in Contract costs.

3. At the completion of the work, all water systems shall be adjusted for quiet operation

4. All automatic control devices shall be adjusted for proper operation.

5. All plumbing fixtures and exposed metal work shall be cleaned and polished. All roof drain, deck drain, floor drain strainers and traps shall be cleaned of all debris.

6. All items of equipment shall be thoroughly inspected and any items dented, scratched or otherwise damaged in any manner shall be replaced or repaired and painted to match the original finish. All items so repaired and refinished shall be brought to the attention of the Architect for inspection and approval.

3.06 SPECIAL TOOLS

A. Provide any and all special tools recommended by the manufacturer of items furnished, noted as not being commonly available.

3.07 CERTIFICATES OF APPROVAL

A. Upon completion of the work, furnish to the Owner through the Architect in duplicate, certificates of inspection and/or approval from state and local inspection authorities having jurisdiction, indicating the installed plumbing and fire protection system's compliance to their requirements.

3.08 QUIET OPERATION

A. All work provided under this Section of the Specifications shall operate under conditions of load without sound or vibration which is abnormallly objectionable for such equipment in the opinion of the Architect. In case of moving machinery, sound or vibration noticeable outside of the room in which it is installed, or annoyingly noticeable inside its own room will be considered objectionable, shall be corrected in an approved manner by this Contractor at no change in Contract amount.

3.09 SYSTEMS

A. Sanitary Drainage Piping:

1. Although the trenching and backfilling will be performed under another Section of the Specifications, this Contractor will be responsible for the proper execution of this work and shall do all hand trimming of trench bottoms. All piping must be laid on good foundation with solid uniform bearing through the entire length. The bottom of all trenches will be trimmed by hand to receive pipe and finished bedding grade. The bottom of all trenches shall be rounded so that half of the circumference of the pipes will rest firmly on compacted gravel at proper line and grade. Bell holes shall be dug to insure pipe resting for its entire length upon the bottom of the trench.

2. This Contractor shall be responsible for checking each pipe for alignment, center line elevation and invert grade for underground installations.

3. At times when work is not in progress, open ends of pipe and fittings shall be securely closed to the satisfaction of the Architect so that no trench water, earth or other substance will enter the pipe or fitting. Any section of a building drainage system that is found defective in material, alignment, grade or joints before acceptance shall be corrected to the satisfaction of the Architect. Pipe laid through rock excavation shall rest on a 6 inch layer of well compacted gravel.

4. All sanitary (soil, waste and vent) drainage piping 3 inches and smaller in diameter shall pitch a minimum of 1/4 inch per foot, piping 4 inches and larger in diameter shall pitch a minimum of 1/8 inch per foot.

5. Soil, waste and vent stacks shall be connected as shown and extended through the roof a minimum of 18 inches. Soil, waste and vent pipes shall be concealed unless otherwise noted.

6. Branch connections to each drainage system shall be made with "Wye" and long turn "Tee Wye" fittings. Installation of short radius 1/4 bends, common offsets, double hub fitting and saddles will not be approved. Installation of short "Tee Wye" fittings will be permitted for vertical piping only, and only where space conditions will not permit the use of long turn fittings. Only fittings conforming to the Code shall be installed.

7. Changes in direction of each drainage system shall be made with "Wye" branches and 1/8 bends. Provide long sweep bends at bottom of stacks with a vertical cleanout just above the floor at places where a "Wye" and 1/8 bend and end cleanout cannot be installed.

8. Every fixture shall be separately trapped and the traps must be vented unless an approved battery vented system is being installed. Floor drains shall be considered as a fixture.

9. Vents shall be connected to the discharge of each trap in the sanitary system, thence carried individually to a point above the flood level of the fixture before connecting with any other vent pipes. Pitch the branch vents back to the fixtures.

10. Collect individual vent pipes together in branch vent lines and connect to vent stacks. Wherever possible, vent stack offsets shall be made with 45 degree fittings. The vents passing through the roof shall be a minimum size of 4 inches in diameter.

11. Cleanouts shall be provided in drainage piping at changes in directions, at foot of stacks or other required points so that all portions of the lines will be readily accessible for cleaning or rodding out.

12. Cleanouts shall be of the same size as the pipe installed in up to 4 inches in diameter and not less than 4 inches in diameter for piping larger than 4 inches in diameter.

13. The maximum horizontal distance between cleanouts; in piping 4 inches in diameter and smaller shall not be more than 50 feet apart; in piping 5 inches in diameter and larger shall not be more than 100 feet apart.

14. Traps on sanitary piping not integral with fixtures and in accessible locations shall be provided with a brass trap screw protected by the water seal, and will be regarded as a cleanout.

15. Test tees with brass cleanout plugs shall be provided at the foot of all vertical soil, waste and storm drainage stacks and at each floor. Wherever cleanouts on vertical lines occur concealed behind finished walls, they shall be extended to back of finished walls and a wall plate shall be provided.

B. Cold, Hot and Hot Water Return Piping:

1. Vacuum breakers shall be installed on supplies to each piece of equipment to prevent backsiphonage.

2. Branch lines from water service or main lines shall be taken off the top or bottom of main, using such crossover fittings as may be required by structural or installation conditions.

3. Provide shock absorbers at special equipment and tops of all risers.

4. There shall be a 1/2 inch drain valve provided for each low point in the piping, so that all parts of each water system can be drawn-off.

5. Provide suitable means of thermal expansion for the hot water and hot water return piping using swing joints, expansion loops and long-turn offsets as required to suit building conditions. Where space conditions do not permit the installation of expansion loops, mechanical expansion joints shall be provided.

6. Piping connections to equipment shall be provided with unions or flanges to permit convenient disassembly for alterations and repairs.

7. No piping shall be installed in a manner to permit back siphonage or any flow of water from sanitary or drainage systems into the water systems or their distribution piping under any conditions.

8. Air gaps, open end of funnel drains, and approved vacuum breaking devices shall be provided as specified or as indicated on the Drawings. Piping to hose-end faucets or hose-end fittings, or any fixtures where water supply outlet is below the fixture overflow rim shall have vacuum breakers.

9. Where flanges are installed in the water systems, red rubber gaskets shall be installed between each pair of flanges.

10. Heating of copper tubing to eliminate the installation of fittings will not be permitted.

11. Piping systems shall be kept clean during all phases of work. Open ends of incomplete piping shall be protected to prevent the entrance of foreign materials.

12. Pipe shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing.

13. Provide copper plated friction clamps on the cold water supplies to each urinal flushometer. Friction clamp shall be firmly clamped to the pipe and shall be firmly attached to the unfinished side of the adjacent wall structure.

14. Pipe anchors shall be provided in the hot water and hot water recirculating piping systems to permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points, and shall be designed for the particular locations and loading conditions.

15. Pipe guides shall be provided in the hot water and hot water recirculating piping systems to allow the expansion and contraction of the pipe lines to move freely with the expansion joint or loop.

C. Sprinkler and Standpipe Systems:

1. Provide complete automatic sprinkler coverage for all areas indicated to be protected by sprinklers. Refer to drawings and specifications for area hazards and required densities.

2. Provide water flow and monitor switches in the standpipe and sprinkler systems.

3. This Contractor shall comply with all rules, codes, ordinances, regulations and requirements of all legally constituted authorities having jurisdiction over the whole, or any part of the work herein specified. These rules and regulations supplement this Specification and shall take precedence in any case of conflict.

4. Materials and equipment furnished in connection with the installations shall be new and furnished in accordance with the requirements of the Standards of the NFPA Bulletin Nos. 13, 14, and 20 and they shall be the best grade and quality of their respective kinds, free from natural, manufacturing or construction flaws, defects or irregularities and the finish, fitting and workmanship shall be equal to the highest commercial grade.

5. Sprinkler system shall be zoned to provide separate controls for each floor. Each zone shall include an indicating control valve and suitable provision for draining. Piping shall be arranged so that any one floor zone may be energized independently.

6. Sprinkler system shall be installed in such a manner as to harmonize with the special architectural features of the building. All information required by this Contractor con-

cerning the special architectural features may be obtained from the Contract Documents.

7. Systems shall include, but are not limited to sprinkler heads and escutcheons, control valves, check valves, electric bells and alarms, piping, fittings, hangers, drains, Inspector's test connections, flow switches, control valve monitor switches, fire department valves, fire pump test valves, flow meter, roof manifold, signs and other identification markings as required.

D. Gas System:

1. Installation of the gas piping distribution system shall be done in conformance with the rules and regulations of the Massachusetts Fuel Gas code and the local gas company.

2. Piping shall be installed with an 8 inch long sediment leg at the base of all drops and shall be arranged with drain valves at all low points. All changes in directions shall be made with plugged tee for cleaning out piping.

3. Requirements specified herein for Water System branch lines, equipment connections, valve locations and changes in direction shall apply to all interior gas piping.

3.10 GENERAL INSTALLATION REQUIREMENTS

A. Piping Installation:

1. Install piping approximately as shown on the drawings and as directed during installation by the Architect.

2. Piping shall be installed straight and direct as possible forming right angles or parallel lines with building walls and other piping and neatly spaced.

3. The horizontal runs of piping, except where concealed in partitions, shall be installed as high as possible.

4. Piping or other apparatus shall not be installed in such a manner as to interfere with the full swing of the doors and access to other equipment.

5. The arrangement, positions and connections of pipes, fixtures, drains, valves, and the like, indicated on the drawings shall be followed as closely as possible, but the right is reserved by the Architect to change locations and elevations to accommodate the work, without additional compensation for such change.

6. It shall be possible to drain the water from all sections of each cold, hot and hot water return piping system. Pitch piping back to drain valves.

7. Screwed piping of brass or chrome plated brass shall be made up with special care to avoid marring or damaging pipe and fitting exterior and interior surfaces.

8. Small fittings shall be screwed up close to the shoulders of male threads. Lampwick, cord, wool, or any other similar material shall not be used to make up thread joints.

9. Screwed pipe and copper tubing shall be reamed smooth before installation.

10. All exposed piping in connection with fixtures shall be chrome plated. Where chrome plated piping is installed, cut and thread pipe so that no unplated pipe threads are visible when the work is completed.

11. Reducing fittings, unless otherwise approved in special cases, shall be provided in making reduction in size of pipe. Bushings will not be allowed unless specifically approved.

12. Remove and replace with new materials, any copper or brass piping (chrome plated or unplated) showing visible tool marks.

13. Vertical risers shall be firmly supported by riser clamps, properly installed to relieve all weight from the fittings.

14. Any piece of pipe 6 inches or less in length shall be considered as a nipple.

15. All water service piping shall be kept a sufficient distance from other work to permit finished covering to be not less than 1-1/2 inches from other work and not less than 1-1/2 inches between the coverings (insulation) on the different services.

16. Final connection to the interior storm, garage and sanitary building drains to their respective sewer shall be made gastight by this Contractor.

17. All pipe and fittings shall be manufactured in the United States of America and in accordance with the Commercial Standards, American National Standards Institute and American Society of Testing Materials.

B. Hanger Installation:

1. All piping shall be supported from the building structure by means of approved hangers and supports, to maintain proper grading and pitching of lines, to prevent vibration and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

2. Maximum spacing of hangers on runs of pipe (vertical and horizontal) having no concentration of weight shall be as follows:

   a. Schedule - Hanger spacing in feet/pipe material.

Pipe Size (Inches)	Iron or Steel	Brass or Copper
1/2	5	5
3/4	6	6
1	7	6
1-1/4	9	7
1-1/2	9	8
2	10	8
2-1/2	11	10
3	12	10
3-1/2	13	11
4	14	12
5	16	12
6	17	12

3. Maximum spacing of hangers on soil pipe shall be five feet and hangers shall be provided at all changes in direction. Vertical Hanger rods to support piping from the structure or supplementary steel shall not exceed four feet in total length. Where pipe support assemblies exceed four feet in total length vertically, this Contractor shall provide factory fabricated channels and all associated accessories.

4. Friction clamps shall be installed at the base of the plumbing risers and at each floor (above or below floor slabs). Friction clamps installed above floor slabs shall not be supported from or rest on floor sleeves.

5. Provide hangers at a maximum distance of two feet from all changes in direction (horizontal and vertical) and on both sides of concentrated loads independent of the piping.

6. Hangers, in general, for all horizontal piping shall be Clevis type hangers. These hangers shall be sized to fit the outside diameter of the pipe insulation and insulation protectors (sheet metal shields) specified herein. For sprinkler/standpipe systems hangers shall be approved black malleable iron, heavy duty pattern having two (2) parts bolted together.

7. All vertical drops and runouts (including insulated pipes) shall be supported by split ring hangers with extension rods and wall plates. These hangers shall be copper plated when used on uncovered copper tubing. Supports on insulated vertical piping shall be sized to fit the outside diameter of the pipe insulation with 360 degree insulation protector.

8. Provide on all horizontal insulated lines, pipe covering protectors (shields) at each hanger. Each protector shall be sized to fit the outside diameter of the Pipe insulation.

9. Retaining straps shall be provided with all beam clamps.

10. All supplementary steel including factory fabricated channels and associated aaccessories, including 12 inch long sheetmetal shields, throughout the project for this Section of the Specifications both suspended and floor mounted shall be provided by this Contractor and shall be subject to the approval of the Architect.

11. Hangers shall not pierce the insulation on any insulated pipe except when prior approval is given.

12. Wire, tape or wood fastenings for shims or support of any pipe or tubing shall not be used.

13. Remove all rust from the ferrous hanger equipment (hangers, rods, and bolts) and apply one coat of red lead immediately after erection.

14. Piping at all equipment and each control valve shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping at equipment shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional support after these items are removed.

15. All piping shall be independantly supported from the building structure and not from the piping, ductwork, conduit or ceiling suspension systems of other systems.

16. Installation of hangers which permit wide lateral motion of any pipe will not be acceptable.

17. "C" clamps installed with pipe hangers or equipment hangers will not be permitted unless provided with retaining straps.

18. Underground installations - hangers and rods shall be wired brushed prior to installation and given two (2) heavy coats of asphaltum. Hanger rods shall be secured to reinforcement steel by welding.

C. Pipe Covering Installation:

1. Before pipe covering is applied, all pressure tests shall have been performed and approved. Also, before pipe covering is applied to all domestic and fire protection water piping, all horizontal storm and sanitary piping inlcuding vents in the parking levels, all electrical heat tracing shall have been provided, tested and approved. Electric heat tracing will be provided under Division 16.

2. Pipe covering shall be applied over clean, dry surfaces.

3. Pipe covering shall be continuous and shall be carefully fitted with side and end joints butted firmly and tightly together and finished as specified herein.

4. Pipe covering and auxiliaries shall be kept dry during storage and application.

5. Adhesives, cements and coatings shall not be applied when the ambient temperature is below 40 degrees Fahrenheit.

6. Valve bodies shall have covering applied up to the stem.

7. It is the intent of this Specification that all vapor barriers be sealed and be continuous throughout. Staples shall not be used on vapor barrier jackets.

8. Where pipe covering ends at equipment or fixtures, end caps on the covering shall be provided.

9. Adequate operating clearances shall be provided at control mechanisms.

10. Pipe covering shall be provided on all piping passing through ceilings and through the interior above ground sleeves (wall and floor).

11. Pipe covering for flanges shall overlap the adjoining pipe by a minimum of 3 inches on each side.

12. All voids and or seams in insulation shall be filled with mineral cement or insulating cement and finished as specified herein.

13. In the event staples are used, they shall be coated with a vapor barrier mastic after installation and taped. These staples shall not be visible on finished installation.

14. End joints of each section of the installed pipe covering shall be tightly butted.

D. Installation of Sleeves, Inserts and Escutcheons:

1. Sleeves in floors shall be set one (1) inch above the finished floor surface or as indicated on the Architectural Drawings.

2. Sleeves through interior masonry or non-masonry walls or partitions shall be set flush with the finished surfaces of the wall or partition.

3. Field drilling for inserts required for work under this Section of the Specifications shall be provided by this Contractor.

4. Each interior wall or partition sleeve shall be packed with foam or glass wool to within one inch of each face of wall and the remaining portion of each end of sleeve shall be sealed with mineral fiber rope.

5. Escutcheon shall be installed around all exposed insulated or bare pipe, except water closet starts or bends passing through a finished floor, wall or ceiling. Escutcheons shall fit snugly around the bare pipe or insulated pipe.

E. Valve Installation:

1. Location of Valves: There shall be valves where indicated on the drawings and where specified as follows:

a. At building service entrances, foot of all supply risers, branches to separate fixtures, equipment, hose bibbs, connections to other systems and sectionalizing points in each system.

b. Each fixture supply shall have a separate angle stop or straight stop finished like the pipe it services.

c. Each piece of equipment shall have isolation valves for each service connected.

d. At the front of each riser, on the inlet and outlet side of backflow preventors and special control valves.

e. At the low points of each water system including trapped sections, provide a tee with 1/2 inch branch and valve with 3/4 inch hose end adapter and attached chain with cap.

f. Valves shall be located to permit easy operation, replacement or repairs.

g. Shut-off valves in the Standpipe and Sprinklers system shall be installed at the base of each combined riser, in each sprinkler control station on each floor, where indicated on the Contract Drawings, required by NFPA pamphlets 13, 14, 20, and the Owners insuring agency.

2. Provide balancing valves in hot water recirculating piping system to permit an even temperature throughout.

F. Installation of Gauges and Thermometers:

1. Thermometers and pressure gauges shall be installed in such a manner as to cause a minimum restriction to the flow in the pipes and so that they can be easily read from the floor.

2. Thermometers shall be installed in the outlet piping from the hot water heater and the hot water circulating pump.

3. Pressure gauges in the sprinkler and standpipe systems shall be installed where required by the appropriate Underwriter.

G. Installation of Plumbing Fixtures:

1. General

a. Refer to Architectural Drawings for locations and mounting heights of all plumbing fixtures, electric water coolers and showers.

b. Provide with all plumbing fixtures, all trim, supports, fittings, connections and all incidentals necessary to make a complete installation in accordance with plumbing codes, and the Contract Documents.

c. All visible hanger nuts and all escutcheons shall be chrome plated over nickel plate.

2. Fixture Supports

a. All fixtures (including electric water coolers) shall be supported and fastened to the building structure. The method of support for each type fixture shall be as specified herein, except when the fixture designations on the Contract drawings indicate modifications.

b. Lavatories, unless otherwise specified herein, shall be generally supported on counter tops with chrome plated trim.

c. Urinals shall be supported by floor mounted carrier with support plate, bearing plate, adjustable extension, tubular uprights, block bases and chrome plated trim.

d. Installations shall be complete with all necessary bolts, nuts and washers, iron or brass connecting nipples between fixtures and piping system of the proper length and graphited asbestos gaskets for closet connections.

e. Where all wall hung fixtures are secured to masonry walls or partitions they shall be fastened with 1/4 inch through bolts provided with nuts and washers at back. Bolt heads and nuts shall be hexagon and exposed bolts, nuts, washers and screws shall be chromium plated brass.

f. Where secured to concrete or brick walls, they shall be fastened with brass bolts or machine screws in lead sleeve type expansion shields and shall extend at least 3 inches into solid concrete or brick work, except fixtures specified to be supported by chair carriers.

3. Fixture Trim

a. All materials specified to be chromium plated shall be thoroughly cleaned and polished before plating and plate shall be heavily, thoroughly and evenly applied, guaranteed not to strip or peel.

b. Where escutcheons are not furnished with plumbing fixtures, this Contractor shall supply them. Escutcheons shall be the type and material specified herein.

c. Each fixture shall be separately trapped using the type and size of trap specified herein and required by the Plumbing Code.

d. Unless otherwise specified, faucets and all exposed fittings shall be chromium plated. Chromium plating for brass shall be applied on a first plating of nickel.

e. All fixtures requiring hot and cold water shall have the cold water faucet on the right hand side of the fixture and the hot water faucet on the left hand side of the fixture.

f. All brass shall conform to brass tubing and shall be not less than No. 17 gauge.

H. Sewer Installation:

1. Sewer installation shall be accurate, with the pipe installed straight and true to grades established on the Drawings. Connections to structures (i.e. manholes, gas-sand interceptor) and building drain shall be made watertight.

3.11 FIXTURE PROTECTION AND CLEANING

A. Water closets, lavatories, electric water coolers, and urinals shall be boarded over and all other fixtures protected with pasted on paper. Post notice prohibiting the use of all fixtures prior to acceptance.

B. All plated or polished fittings, pipes and appliances shall be coated with vaseline immediately after installation and shall be finally highly polished and free from all marks and foreign substances when directed by the Architect.

C. Thoroughly clean all fixtures prior to final acceptance.

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PART 1 - GENERAL

1.01 GENERAL

A. Review all drawings and all sections of the Specification for provisions therein affecting the work of this section. The scope of work shall include, but shall not be limited to, the following:

1. Furnishing and installing gas fired hot water boilers, including gas trains and gas flues.

2. Furnishing and installing hot water piping system with piping accessories, circulating pumps, and perimeter fin tube radiation with enclosures.

3. Furnishing and installing of mechanical ventilation for toilets, kitchens, laundry areas, mechanical rooms and various spaces as indicated on the drawings.

4. Furnishing and installing thermal and acoustic insulation.

5. Furnishing and installing chemical water treatment for the hot water system.

6. Providing vibration control as indicated on the drawings and as specified herein.

7. Furnishing and installing a complete system of automatic temperature control as indicated on the drawings and as specified herein.

8. Testing, adjusting and balancing of the hot water heating system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The specifications for the overall construction delineate various items of work under each trade. The list below sets forth the work not included in this section of the specifications.

B. In the absence of more detailed information, this list shall be taken as a specified instruction to the HVAC trade to exclude the work not assigned to it.

C. The following items of labor and materials incidental and/or related to the installation of HVAC work will be provided and/or installed under other sections of these specifications at no cost to this Contractor.

1. List

a. Temporary heat, light, power and water.

b. Access panels installation.

c. Excavation and backfilling inside and outside of building.

d. Keeping site and excavation free of surface water during construction.

e. Flashing and counter flashing.

f. Cutting and patching.

g. Equipment concrete foundations, housekeeping pads and machine bases.

h. Finish painting of all exposed work.

i. Exterior wall louvers.

j. Setting and caulking of louvers.

k. Undercut and louvered doors.

2. The Plumbing Contractor will provide the following:

a. Make-up water valved connections for the hot water heating system.

b. Piping to the boiler gas trains and vents from the gas trains.

3. The Electrical Contractor will provide the following:

a. All motor starters, except as noted in HVAC specifications and drawings, and wiring between starter and motor.

b. All power wiring for mechanical equipment motors.

c. All motor to motor (starter to starter) interlock wiring.

D. For items which are to be installed but not furnished as part of the HVAC work, the HVAC work shall include:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field make-up and internal wiring as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connections to building systems including the purchase and installation of all termination fittings necessary to adapt and connect them to the building systems.

E. Items which are to be installed but not furnished as part of the HVAC work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the HVAC work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The HVAC work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.03 CODES, PERMITS AND FEES

A. Unless otherwise specified or indicated, materials and workmanship and equipment performance shall conform with the latest edition of the following standards, codes, specifications, requirements and regulations.

1. All applicable ASHRAE Standards.

2. Hydraulic Institute's requirements.

3. American Boiler Manufacturer's Association.

4. Mechanical Contractor's Association recommendations.

5. American National Standards Institute requirements.

6. National Electrical Manufacturer's Association.

7. Sheet Metal and Air Conditioning Contractor's National Association.

8. American Society for Testing Materials requirements.

9. Massachusetts State Uniform Fire Prevention and Building Code.

10. Occupational Safety and Health Administration regulations.

11. National Fire Protection Association requirements.

12. Air Moving and Conditioning Association requirements.

13. Massachusetts State Energy Conservation Code.

B. All other state and local codes and/or authorities having jurisdiction including any and all other standards specifically indicated in other paragraphs of this specification.

C. The HVAC Contractor shall give all notices, file all plans, obtain all fees and obtain all necessary approvals from authorities having jurisdiction, deliver all certificates of inspection and test approvals to the Owner.

1.04 WARRANTIES

A. The HVAC Contractor shall submit manufacturer's warranties for products as specified in this Section. All warranties shall be submitted prior to final payment.

B. All materials, items of equipment and workmanship furnished under this section shall carry standard warranty against all defects in material and workmanship for a period of not less than one (1) year from date of final acceptance of the work. Any fault due to defective or improper material, equipment, workmanship or manufacturing design which may develop within that period shall be made good, forthwith, by and at the expense of this Contractor, including all other damage done to areas, materials and other systems resulting from the failure.

C. This Contractor shall guarantee that all elements of the systems meet the specified performance requirements set forth herein or as indicated in the drawings.

D. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by this Contractor at no additional cost to the Owner.

1.05 INSPECTION OF SITE CONDITIONS

A. Before starting work, the Contractor shall visit the site and examine the conditions under which the work has to be performed. He shall report in writing any conditions which might adversely affect the Contractor's work and shall not proceed with the work until defects have been corrected and conditions are satisfactory.

1.06 SUPERVISION

A. This Contractor shall supply the service of an experienced and competent supervisor who shall be in charge of the Contractor's work at the site.

1.07 EQUIPMENT AND MATERIALS

A. All materials, equipment and accessories provided under this section shall be new and unused products of recognized manufacturers as approved by the Owner.

B. Provide materials in conformance with herein above listed agency's applicable codes and regulations. Should requirements of the specifications conflict with any code or regulation, the more stringent requirement shall apply.

1.08 ELECTRIC MOTORS

A. Motors shall be built in accordance with latest standards of NEMA and as specified. Motor shall be specifically and expressly wound for voltage required.

B. Motors shall be tested in accordance with standards of ANSI C50 and conform therewith for insulation resistance and dielectric strength.

C. Motors shall be provided with conduit terminal boxes of size adequate to accommodate conduits and wires as sized on electrical drawings or specified under this Section.

D. Capacity shall be sufficient to operate associated driven devices under conditions of operation and load and with overload and at least horsepower indicated or specified. All motors shall be of the high efficiency, low energy consuming type most suitable for the application and its specific environmental location in this building. All motor replacements necessary for compliance to the application shall be at no additional cost to the Owner.

E. All motors shall be suitable for continuous duty at rated horsepower with temperature rise not to exceed 40 degrees C for drip-proof motors, 50 degrees C for splash-proof motors, 55 degrees C for totally enclosed or explosion-proof motors. All motors shall be capable of 25 percent overload without overheating and suitable for operation for the ambient conditions of its specific location in the building.

F. Direct connected motor shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except fractional HP motors, which shall have slotted mounting holes.

G. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed and current characteristics.

H. Motors smaller than 1/2 horsepower shall be capacitor-starter or split-phase type designed for 120 volts, single phase, 60 cycle operation unless otherwise specified. This shall be coordinated with the electrical contractor.

I. Motors 1/2 horsepower and larger shall be squirrel cage induction type designed for 208 volts, three-phase, 60 cycle operation unless otherwise specified.

J. Motor control centers will be furnished and installed by the Electrical Contractor.

1.09 STORAGE AND PROTECTION

A. The HVAC Contractor shall arrange for and provide a storage space or area at the job site for all HVAC equipment and materials to be installed in the project. The exact location of portable storage vans at the job site or protected storage areas within the building construction, conditions permitting, shall be arranged with the Owner.

B. Storage space shall be provided by the HVAC Contractor for the storage of all equipment and materials received and/or that are to be received for installation in this project.

C. All HVAC equipment and materials, upon receipt at the job site, shall be thoroughly inspected by the HVAC Contractor.

D. After inspection, all HVAC equipment and materials shall be moved to the storage van or area provided. All equipment and materials shall be placed in the storage areas so as to prevent damage to same.

E. During the construction period, the HVAC Contractor shall adequately protect against damage to all equipment and materials installed during the progress of the construction.

F. The HVAC Contractor shall, before completing his work and before final inspection, replace all damaged or defective equipment and material as required.

1.10 SURVEYS AND MEASUREMENTS

A. This Contractor shall base his measurements, both horizontal and vertical, from established referenced points and shall be responsible for correct laying out of his work.

B. In the event of discrepancy between actual measurements and those indicated, this Contractor shall notify the proper authority in writing and shall not proceed with his work until written instructions have been issued.

1.11 COORDINATION

A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow speedy and efficient completion of the project.

B. This Contractor shall furnish to the other trades advance information on locations and sizes of all frames, boxes, sleeves, and openings needed for his own work, and also furnish information and shop drawings necessary to permit trades affected by this Contractor's work to install their work properly and without delay.

C. Where there is evidence that work of this Contractor will interfere with the work of other trades, this Contractor shall assist in working out space conditions to make satisfactory adjustments.

D. This Contractor shall, make reasonable modifications in his work as required by normal structural interferences, pay all expenses for additional openings or relocating or enlarging existing openings thru concrete floors, walls, beams and roof provided for HVAC work.

E. If this Contractor installs his work before coordinating with other trades so as to cause interference with the work of such trades, he shall make all necessary changes in his work to correct the condition without extra cost.

F. This Contractor shall protect all materials and work of other trades from damage that may be caused by his work and shall be responsible for repairing any damages caused by him without any extra cost to the Owner.

1.12 CUTTING AND PATCHING

A. Sleeves, inserts, anchor bolts and similar items set into concrete or masonry or the work of other trades shall be furnished and installed by this Contractor. This Contractor shall be responsible for all such items necessary to hang or support his equipment.

B. When, in order to accommodate this Contractor's work finished materials of other trades must be cut or fitted in the shop, this Contractor shall furnish the necessary drawings for transmittal to the trades whose materials must be cut or fitted.

C. This Contractor shall do all drilling and cutting of small holes in concrete walls and floors as required for sleeves and supports with the approval of the Owner.

D. This Contractor shall provide all information for cutting and patching of the work under his trade. Any cutting and patching of work of other trades to accommodate the work of this Contractor, shall be paid by this Contractor.

1.13 ACCESSIBILITY

A. All work shall be installed so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval.

1.14 ACCESS PANELS

A. Access panels for walls, ceilings and floors will be furnished and installed under finish trade section. HVAC trade shall be responsible for coordinating size and location of all access panels.

B. Access panels shall be located at all duct access doors and as indicated on drawings or as required to permit access for service and maintenance or replacement of all concealed HVAC equipment and devices.

C. All access panels shall be installed, in a workmanlike manner, in closets, storage rooms and/or other non-public areas, positioned so that the equipment can be easily reached, and the size shall be sufficient for this purpose (min. 16" x 16"). When access panels are required in corridors, lobby or other habitable areas, they will be located as directed by the Owner.

D. Access panels shall be prime painted and provided with cylinder lock and two keys as manufactured by Milcor. Type shall be as follows:

1. Dry Wall Surfaces Milcor Type DW

2. Masonry Construction Milcor Type M

E. Access panels shop drawings shall be submitted for approval.

1.15 FIREPROOFING

A. All clips, hangers, clamps, supports and other attachments to the fire rated structure shall be coordinated with other trades in order to avoid any damage to the fireproofing.

B. All conduit and other items which would interfere with the proper application of fireproofing shall be installed after the application of fireproofing work.

1.16 TEMPORARY HEAT

A. The HVAC Contractor shall coordinate his work with the progress of the construction so that the permanent heating system will be ready to provide temporary heat as soon as the building is closed in.

B. The HVAC Contractor shall be in charge of and provide all labor required for the attendance and operation of the permanent heating system that is used for temporary heating purposes. Continuous direct attendance shall be provided whenever the permanent system is in operation.

1.17 REMOVAL OF RUBBISH

A. The HVAC Contractor shall keep the building and site clean from his own rubbish and/or waste materials and, upon completion of his contract, shall leave the building, site and installation in a clean acceptable condition.

1.18 SAFETY PRECAUTIONS

A. The HVAC Contractor shall comply with all of the safety requirements of OSHA throughout the entire construction period of the project.

B. The HVAC Contractor shall furnish, place and maintain proper guards for prevention of accidents and any other necessary construction required to secure safety of life and/or property.

1.19 PORTABLE OR DETACHABLE PARTS

A. The HVAC Contractor shall retain in his possession and shall be responsible for all portable and/or detachable parts and portions of the installation and all other devices or materials that are relative to and necessary for the proper operation and maintenance of the HVAC system until final completion of his work.

B. The HVAC Contractor shall replace all stolen, lost or damaged items relative to the installation and operation of the HVAC system at his own expense before the building is accepted by the Owner.

1.20 SELECTION AND ORDERING OF MATERIALS

A. The HVAC Contractor shall arrange for purchase and delivery of materials and equipment required in ample quantities and at the proper time. Substitution on account of inability to obtain delivery will not otherwise be allowed as the work proceeds.

1.21 SLEEVES, INSERTS AND PLATES

A. This Contractor shall coordinate with other trades the location of and maintaining in proper position, sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event of incorrectly located preset sleeves, inserts, anchor bolts, etc. requiring cutting and patching of finished work, it shall be done under this Contractor's costs.

B. Unless otherwise specified herein, all pipes and ductwork passing through floors, walls or partitions shall be provided with sleeves.

C. All openings around the sleeves shall be packed with rigid sound and fireproof material in order to avoid noise transmission from one space to another. The clearance space inside the sleeves shall be packed with fiberglass material.

1.22 QUIET OPERATION

A. HVAC equipment shall operate without sound or vibration which is abnormally objectionable for such equipment. Sound or vibration noticeable outside of the room in which it is installed, or annoyingly noticeable inside its own room will be considered objectionable. Objectionable sound or vibration shall be corrected in approved manner by this Contractor at no cost to the Owner.

1.23 TOOLS, EQUIPMENT, STAGING AND HOISTING

A. All necessary tools and equipment such as conduit bending machines, staging for erection of HVAC equipment shall be furnished at the job site by the HVAC Contractor for fabrication and erecting all related equipment covered by this section of the specifications.

1.24 BASES AND FOUNDATIONS

A. All concrete bases, supports and grouting will be furnished and installed under Section, CONCRETE.

B. The HVAC Contractor shall furnish to the appropriate trade all required foundation sizes, bolts, washers, sleeves, plates and templates for HVAC equipment.

C. The size of the foundation bolts shall be as recommended by the manufacturer.

D. All equipment shall be set on the foundation and shimmed level with steel shims for uniform bearing by this Contractor.

1.25 EXCAVATION AND BACKFILLING

A. All excavation and backfilling required for equipment and piping installed under this section will be performed as specified.

B. This Contractor shall furnish to the appropriate trade all required information as to the locations, sizes, grades and elevations of all conduit, equipment and foundations requiring excavation and shall be responsible for same.

C. The minimum width of trenches for pipes shall be such as to give a clearance of at least eight inches on each side and bottom of fittings.

D. All irregularities in the trench bottom or where the excavation has exceeded the depth required shall be filled with sand properly compacted to the required depth.

E. Backfill shall be free of rocks, debris, cinders or other corrosive material.

1.26 DAMAGE TO OTHER WORK

A. The HVAC Contractor shall be held responsible for and shall pay for all damages to other work caused by his work or workmen.

B. Repairing of such damages will be done by the Contractors who installed the work.

1.27 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

A. Furnish and install all supplementary steel, channels and supports required for the proper installation, mounting and support of all equipment.

B. Supplementary steel and channels shall be firmly connected to building construction in a approved manner as shown on the drawings or hereinafter specified.

C. The type and size of the supporting channels and supplementary steel shall be determined by the HVAC Contractor and shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.

D. All supplementary steel and channels shall be installed in a neat and workmanlike manner parallel to the walls, floor and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.

E. All supplementary steel, channels, supports and fittings shall be Underwriters' Laboratories, Inc. approved, be galvanized steel and be manufactured by Unistrut or approved equal.

F. All pipe and fittings on all work are to be secured as specified hereinafter.

1.28 CROSS AND INTERCONNECTIONS

A. No HVAC fixtures, equipment, device or piping shall be installed which will provide a cross or interconnection between a distributing supply for drinking or domestic purposes and non-potable supply or a drainage system or a soil or waste pipe which will permit or make possible the back-flow of sewage, polluted water or waste into the domestic water supply system.

1.29 JURISDICTIONAL DISPUTES

A. It shall be the responsibility of this Contractor to pay all costs for subletting any work that may be required to perform any of the work shown on the other trade's Contract Drawings or specified herein in order to avoid work stoppages due to jurisdictional disputes. The basis for subletting work in question, if any, shall conform with precedent agreements.

1.30 TYPICAL DETAILS

A. Typical details where shown on the drawings shall apply to each and every item of the project where such items are applicable. They are not repeated in full on the drawings, which in many cases are diagrammatic only, but with the intention that such details shall be incorporated in full. Any alternate method used by the Contractor shall have prior approval before installation.

1.31 SHOP DRAWINGS

A. Shop drawings shall be submitted in accordance with requirements specified.

B. Documents will not be accepted for approval unless:

1. They comply as to number of copies and type of paper with the requirements of this specification.

2. They include complete information pertaining to appurtenances and accessories.

3. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not applicable.

C. Submit shop drawings for all equipment and material specified in Part 2 and as indicated on the drawings.

D. Substitutions

1. Where the HVAC Contractor proposes to use an item of material or equipment other than that shown or specified in the Contract Documents, this Contractor shall assume the cost of and entire responsibility for any change in his work from the work as shown or specified occasioned by approval of such item. In addition, this Contractor shall make all such arrangements and assume all costs occasioned by changes in the work of other trades that he may require in order to install the approved substitution; such changes shall not be a matter for subsequent Change Order increasing the Contract Sum.

1.32 DEFINITIONS

A. As used in this section, the following terms are understood to have the following meaning:

1. Contractor unless otherwise qualified, shall mean the installer of the work under this section.

2. Furnish shall mean purchase and deliver to the project site, complete with every necessary appurtenance and support.

3. Install shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.

4. Provide shall mean "Furnish" and "Install".

5. Work means all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.

6. Piping includes in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

7. Concealed means hidden from sight in chases, furred spaces, shafts, hung ceiling, embedded in construction or in crawl space.

8. Exposed means not installed underground or concealed as defined above.

9. Any work by others means not by HVAC Contractor, but work furnished and/or installed by other Contractors, (performing their respective work) within this Contract.

10. Coordinate means all HVAC work compliance to other trades.

11. Cold Water Piping means make-up water piping.

1.33 TECHNICAL ABBREVIATIONS

A. TDH - Total Dynamic Head.
B. PSI - Pounds Per Square Inch.
C. RPM - Revolutions Per Minute.
D. HP - Horsepower.
E. GPM - Gallons Per Minute.
F. PSIG - Pounds Per Square Inch Gauge.
G. ^{o}F - Degrees Fahrenheit; ^{o}C - Degrees Centrigrade.
H. CFM - Cubic Feet Per Minute.
I. MBH - 1000 BTU Per Hour.
J. RH - Relative Humidity.
K. FPM - Feet Per Minute.
L. Tons - Tons of Refrigeration - 12000 BTU/HR.
M. KW - Kilowatt.
N. db - Decibels.
O. NC Level - Noise Criteria Level.
P. SP - Static Pressure.
Q. TP - Total Pressure.
R. OV - Outlet Velocity.

1.34 DRAWINGS AND SPECIFICATIONS

A. It is the intention of Contract Documents to call for complete, finished work, fully tested and ready for continuous operation.

PART 2 - PRODUCTS

2.01 PIPING, FITTINGS AND ACCESSORIES

A. General:

1. Unless otherwise specified, all piping 2 inch diameter and smaller shall be copper Type "L" hard drawn. Unless otherwise specified all piping over 2-1/2 inch diameter shall be ASTM A120/ASJCW using welding fittings.

2. All connections to apparatus 2 inch diameter and smaller shall be made with 150 pound brass seat unions. All connections to apparatus 2-1/2 inch diameter and larger shall be made with welding neck 150 pound flanges to match flange on valves or apparatus to which attached.

3. All welding fittings shall be ANSI B6.9 and ASTM A-234 North American made steel welding fittings of the same weight and material as the piping to which attached. Tee welds reducing one size or less shall be made with welding tees of the same manufacturer as the welding fittings, or "weldolets" as manufactured by Bonney Forge, Taylor, Tubeturn. Tee welds on branches reducing more than one size shall be made with shaped nipples beveled at both ends and with welding tees when branches are same size as main. All welding shot shall be removed. Unless otherwise indicated, all welding elbows at changes in direction of piping shall be long radius elbows. Use eccentric welding reducing fittings at changes in pipe size for horizontal piping.

4. Welded pipe bevels shall be Mill-beveled or machine-beveled on both ends before being welded. Bevels shall be 35 or 40 degrees. On odd lengths of steel pipe, beveling may be accomplished by means of cutting torch, provided scale and oxide are removed with hammer and chisel and entire surface filed or ground to smooth finish.

5. All fittings for piping 2 inch diameter and smaller shall be wrought copper solder joint, ANSI B16.22, Type L.

6. All piping 2 inch diameter and smaller shall be soldered using 95-5 solder and non-corrosive flux.

7. In all piping systems where pipes of dissimilar metals are jointed, dielectric (insulating) unions suitable for the intended service shall be provided.

B. Welding:

1. Welding shall conform to current standards and recommendations of the American Welding Society of Building Trades.

2. Before assigning any welders to work covered by this specification, this Contractor shall provide the names of pipe welders to be employed for the work, together with each welder's assigned number, letter or symbol which shall be used to identify the work of that welder and which shall be affixed immediately upon completion of each weld. This Contractor shall also submit with the list of names, copies of each welder's certified qualification tests prescribed by the National Certified Welding Bureau or by other reputable testing laboratory using procedures covered in the latest editions of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Operators." Welders must be certified for all positions. Certification shall be by approved agencies other than the Contractor performing the work.

3. If requested by the Owner, this Contractor shall submit identifying stenciled tests coupons made by any operator in question. This Contractor shall require any welder to retake the tests when, in the opinion of the Owner, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no additional expense to the Owner and the welder in question shall not be permitted to work as a welder on this project until he has been recertified. Recertification of the welder shall be made only after the welder has taken and passed the required tests; welder must pass the tests without benefit of retests in order to resume work as a welder on this project.

4. Welding shall conform to the American National Standards Institute for Power Piping ANSI B31.1 - (1977). Welds shall have penetration complete to the inside diameter of the pipe and the recommended spacing and bevels between ends of pipes prior to welding shall be used in all cases to assure full penetration.

C. Hot Water Piping:

1. All hot water supply and return piping 2 inch diameter and smaller shall be Type L hard drawn copper tubing with wrought copper solder joint type or cast brass sweat fittings conforming to ASTM Specification B-88, ANSI Standards B16.22, B16.18, and B16.18a, respectively. Flange fittings shall be Class 150 cast bronze conforming to ANSI Standards B16.24.

2. Fittings for copper tubing shall be Chase Sweat Fittings, Mueller Brass Company's "Streamline" solder fittings, or "Arco" wrought copper fittings. All piping shall be installed in a workmanlike manner, according to the manufacturer's instruction. All joints shall be thoroughly cleaned before connecting. All solder for copper tubing shall have a melting point of not less than 460 degrees F, composed of 95% tin and 5% antimony.

D. Cold Water Make-Up Piping:

1. Furnish and install cold water make-up piping as indicated on the drawings, and as specified herein. Cold water piping shall be furnished and installed from valved outlets furnished and installed by the Plumbing contractor. Cold water piping shall be Type L hard drawn copper tubing with solder joint fittings, using 95-5 tin-antimony solder and non-corrosive flux.

2.02 VALVES AND COCKS

A. Furnish and install all valves and cocks where indicated on the drawings for the operation and maintenance of the heating, ventilating and air conditioning systems. All valves in each class 2-1/2 inch diameter and larger shall be supplied by the same manufacturer. All valves in each class 2 inch diameter and smaller shall be supplied by the same manufacturer. Any deviations from specifications shall be clearly identified in shop drawings.

1. Gate valves 2 inch diameter and smaller shall be ANSI Class 150 with bronze body, solid wedge, inside screw, non-rising spindle, screwed end valves, as manufactured by Jenkins, Walworth or approved equal.

2. Unless otherwise specified or noted on the drawings, gate valves 2-1/2 inch diameter and larger shall be ANSI Class 150 with iron body, bronze mounted, solid wedge, flanged valves, inside screw, non-rising spindle. OS & Y valves shall be ANSI Class 150 and shall be as manufactured by Jenkins, Walworth or approved equal.

3. Globe valves 2 inch diameter and smaller shall be ANSI Class 150 with bronze body, renewable composition disc type valves with discs suitable for the service intended, screwed ends, and shall be as manufactured by Jenkins, Walworth or approved equal.

4. Globe valves 2-1/2 inch diameter and larger shall be ANSI Class 150 iron body, bronze mounted, OS & Y valves with regrind-renew beveled bronze disc and seat ring, flanged ends, as manufactured by Jenkins, Walworth or approved equal.

5. Check Valves

a. Horizontal swing check valves 2 inches and under shall have ANSI Class 150 WSP bronze bodies and trim, screwed ends, intergral bronze seat, regrindable bronze disc and screw-in cap as manufactured by Jenkins, Walworth or approved equal.

b. Horizontal swing check valves 2-1/2 inch and larger shall be ANSI Class 150 iron body bronze mounted, flanged ends, replaceable bronze seat, renewable, regrindable bronze

disc and bolted cover as manufactured by Jenkins, Walworth or approved equal.

c. Vertical lift check valves 2 inches and smaller shall have ANSI Class 150 bronze bodies and trim, screwed ends, integral bronze seat, renewable composition disc and screw-over cap as manufactured by Jenkins, Walworth or approved equal.

d. Vertical lift check valves 2-1/2 inch and larger shall be silent type with semi-steel, 150 pound body, replaceable soft bronze seat and plug, stainless steel spring and retaining screws, as manufactured by Combination Pump and Valve Company, Prince Valve Company, Mueller or approved equal.

6. Butterfly Valves

a. Butterfly valves 2-1/2 inch to 12 inch size shall have ANSI Class 150 self-aligning, semi-lug wafer type cast iron bodies with resilient EPDM seat, 416 stainless steel shaft with acetal bushings, aluminum-bronze disc and infinite position lever operator, as manufactured by Jamesbury, Jenkins or approved equal.

b. All valves shall be rated for a pressure of not less than ANSI Class 150 and each valve shall be factory tested to 110% of its rating. Seat material shall be EPDM capable of operating temperature from $-40^{\circ}F$ to $+250^{\circ}F$. Valves shall have a body neck extended 2 inches to permit the application of insulation without interference with valve actuator.

7. Plug Valves (Balancing or Throttling Valves)

a. Plug valves 2 inch size and smaller shall have ANSI Class 150 H.C.I. bodies, screwed ends, teflon coated plug, plug retainer plate, separate gland adjustment and shall be wrench operated. Valves shall be provided with proper lubricant and not less than 2 wrenches for each valve size. Valves shall be as manufactured by Walworth, Rockwell-Nordstrom or approved equal.

b. Plug valves, 2-1/2 inch to 5 inch size shall have ANSI Class 150 semi-steel bodies, 125 pound flanged ends, teflon coated tapered plug, plug retainer plate, bolted gland adjustment and wrench operators for up to 5 inch. Valves shall be provided with proper lubricant and not less than 2 wrenches for each valve size. Valves shall be Walworth, Rockwell-Nordstrom or approved equal.

c. Plug valve bodies shall be capable of accommodating thermal insulation without interfering with the operation of the valve.

8. Drain Valves

a. Furnish and install a 3/4 inch drain valve with cap and chain at each low point of the water systems, at each strainer blow-out connection and wherever else indicated on the drawings. Drain valves shall be Walworth Co. Fig. 24, or approved equal.

9. Ball Valves

a. Ball valves 2 inch diameter and smaller shall have bronze body rated for 150 psi, similar to Jenkins Fig. 32.A.

b. All valves shall include TFE seat packing and gasket and Type 316 stainless steel ball and stem and shall be as manufactured by Jenkins or approved equal.

B. Sprocket Rims and Chains:

1. A sprocket rim and chain shall be furnished and installed on each hand operated, flanged valve which is inoperable from the floor. Sprocket rims and drains shall be installed by this Contractor.

C. Valve Service:

1. All water system shut-off valves 2 inch diameter and smaller, unless otherwise noted, shall be ball valves.

2. All water system shut-off valves 2-1/2 inch diameter and larger, unless otherwise noted, shall be butterlfly valves.

2.03 GASKETS

A. Unless otherwise specified, make up flanged joints with one piece ring gaskets, 1/16 inch thick. For hot water piping, use equivalent composition to asbestos. For cold water piping, use rubber composition.

B. Asbestos or similar material composition gaskets shall not be used.

C. Gaskets shall be similar to Garlock, Crane, Johns-Manville.

2.04 FLANGED AND THREADED CONNECTIONS

A. Welded Piping: Use steel, welding neck pattern flanges, 150 psi WSP Class ANSI B16.5; ASTM A-181 - Grade I.

B. All flanges shall be faced and drilled to "U.S. Standard" and fitted with machine bolts of proper numbers and size, with semi-finished hex nuts and washers.

C. All screwed joints shall be made tight with teflon tape, teflon compound applied to male threads or other approved method.

2.05 PIPE SLEEVES AND ESCUTCHEONS

A. This Contractor shall be responsible for the location of and maintaining in proper position, sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event that failure to do so required cutting and patching of finished work, it shall be by and done at the expense of this Contractor.

B. All pipes passing through masonry walls, gypsum board fire walls or concrete walls or floor slabs shall be fitted with fireproof wall and floor sleeves as manufactured by Pipe Shields Inc. Hot water piping shall be fitted with model WFB-CS through walls and DFB-CS through floors. All floor sleeves and wall sleeves shall be sized to provide a fiberous material insulation section in the annular space equal to the adjacent thickness of insulation as specified in this section of the specifications under paragraph: "INSULATION". Floor sleeves through mechanical equipment room floor slabs shall be long enough to pass through the slab, 4 inch housekeeping pad and allow 1" above the top of the pad, and shall be schedule 40 steel pipe. All other floor sleeves shall extend 3" above floor and be sealed water tight.

C. All pipes passing through walls, floors and ceilings, except piping concealed above suspended ceilings shall be fitted with chromium plated spun or split type escutcheons with a clamping device for holding the escutcheons in position. Floor escutcheons shall be designed to cover the pipe sleeves and rest upon the finished surface.

2.06 HANGERS AND SUPPORTS

A. Furnish and install pipe supports, hangers and other devices necessary to support firmly and substantially the piping and the apparatus described in this specification.

B. Where the weight of piping or other apparatus makes it impracticable to support the same from the building structure above flanged piping supports shall be installed to support the weight of piping, valves and fittings.

C. Piping shall be provided with steel insulation protection shields at each hanger. The shields shall be 180 degree rolled segments installed outside the vapor barrier. The shield length and gauge thickness shall be as follows:

Pipe Size	Length	Gauge
1-1/2 inch and smaller	6 inch	24
2 inch - 5 inch	12 inch	20

D. All other piping shall be provided with pipe covering protection saddles tack welded to the pipe at each hanger.

E. All piping shall be supported by Worcester hangers as manufactured by Carpenter Patterson, Grinnell Corp., Calco Steel Products Co.

The hanger shall be installed outside the covering on insulated pipe. The rod size and hanger shall be as follows:

Pipe Size	Hanger	Rod Diameter	Maximum Spacing
1-1/4" and smaller	Clevis Hanger	3/8"	8'-0"
1-1/2" and 2"	Clevis Hanger	3/8"	10'-0"
2-1/2" to 3-1/2"	Clevis Hanger	1/2"	12'-0"
4" to 5"	1 Rod Roll Hanger	5/8"	14'-0"

F. Maximum hanger spacing indicated above is for straight runs of pipe. Hangers shall be spaced more closely as required by changes in directions of piping, location of valves, and other devices and the building structure. This Contractor shall provide supplementary steel as required to support piping and equipment.

G. Where the weight of piping or other apparatus makes it impracticable to support same from overhead, flanged pipe standards with chair roll supports shall be used.

H. Where installation conditions necessitate, two rod roll hangers shall be used in lieu of the hanger specified.

I. Clevis hangers shall be Carpenter and Patterson Fig. No. 100.

J. One rod roll hanger shall be Carpenter and Patterson Fig. No. 140.

K. Two rod roll hangers shall be Carpenter and Patterson Fig. No. 142.

L. Chair roll supports shall be Carpenter and Patterson Fig. No. 40.

M. Pipe covering protection saddles shall be Carpenter and Patterson Fig. No. 351, 352, 353 or 354 depending on the thickness of the insulation.

N. Furnish vibration hangers as specified in the article of this specification entitled "VIBRATION CONTROL".

O. Hangers for copper tubing shall be copper plated 1-A bands with 3/8" hanger rods and beam clamps spaced on 10'-0" centers.

P. Piping shall not be supported from ductwork or from other piping.

Q. Pipe guides shall be Carpenter and Patterson Fig. No. 1007 split sleeve steel type suitable for use with insulation thickness of piping in which they are installed.

R. Vertical piping shall be supported by wrought iron riser clamps or base elbows as indicated on the drawings.

S. All adjustable hangers shall be provided with lock nuts.

2.07 EXPANSION COMPENSATORS

A. Furnish and install expansion compensators in the hot water piping where indicated on the drawings. The compensators shall be Keflex Type 7Q, Flexonics Model H.

B. Keflex Type BA anchors and Type B guides shall be installed for each compensator as indicated on the drawings. Guides and anchors shall be supported inside the enclosure on Type BH hangers.

C. The compensators shall be installed in strict accordance with the manufacturer's recommendations.

2.08 EXPANSION LOOPS, ANCHORS AND GUIDES

A. Provisions for expansion in piping mains, branches and risers shall be made by the installation of offsets, expansion loops, or compensators as indicated on the drawings and as required.

B. All piping with loops, or compensators shall be anchored so as to direct all expansion toward the loops, or compensators.

C. Guides shall be installed on both sides of each expansion loop and compensators as indicated on the drawings. Guides shall be constructed as shown in the details on the drawings and shall be Keflex Type P pipe alignment guides.

D. Anchors and guides shall be secured to beams. They shall not be secured to roof or slab decking.

E. All piping with loops shall be anchored so as to throw all expansion toward the loops.

F. Anchors shall be constructed as shown on the drawings.

2.09 STRAINERS

A. Furnish and install a full size Y-pattern strainer on the inlet side of each temperature control valve, each pressure reducing valve, each water circulating pump and where indicated on the drawings except at finned tube radiation locations.

B. Unless otherwise specified, the strainers shall have cast iron or bronze bodies of ample strength to withstand without failure the pressures to which they shall be subjected. They shall have removable cylindrical or conical screens of nickel, copper or brass, and suitable flanges or tappings for connections to the piping they serve. They shall be of such design as to allow blowing out of the accumulated dirt, and to facilitate removal and replacement of a strainer screen without disconnecting the main piping. The strainers on the inlet side of each of the water circulating pumps shall have 40 mesh screens.

C. An approved 1 inch valved dirt blow-out connection shall be made to each strainer, with the gate valve with Jenkins Fig. 372 and Fig. No. 658 cap and chain located six inches to twelve inches below the strainer. In the case of strainers under full water pressure the blow-out connection shall terminate at a point where there will be no danger to personnel or risk of flooding or damage. Valve location shall be no higher than 7' above floor.

D. Strainers 2 inch diameter and smaller shall have screwed ends similar to Sarco Co. Type AT. Strainers 2-1/2 inch diameter and larger shall have flanged ends similar to Sarco AF-125.

E. Where installation conditions necessitate, basket-type strainers with baskets removable from the top, shall be used.

F. The strainers shall be as manufactured by Strong, Armstrong Co., Barnes and Jones, Inc., Mueller or Sarco.

2.10 PRESSURE GAUGES

A. Furnish and install, where shown on the drawings and specified herein, Bourdon Spring type pressure gauge as manufactured by Manning, Maxwell and Moore, Inc., Lonergan Co., H.O. Trerice Corp.

B. The gauges shall be designed for surface mounting with back connections where mounted on panels and shall have white faces with black filled engraved letters. The body of the gauge shall be dull black with the bezel or rim chrome plated. Where gauges are mounted on panelboards, an engraved nameplate shall be mounted below each gauge to identify its service. The nameplate shall be chrome plated with black filled letters. Gauges not mounted on a panelboard shall have their identifying service engraved on the face of the gauge. The accuracy of the gauge shall be within 1 percent of the scale range.

C. A T-handle gauge cock shall be furnished and installed on the system side of each gauge for shut-off purposes.

D. A pressure gauge shall be furnished and installed in the suction and discharge of each water pump, and L.P. and H.P. side of each pressure reducing valve and where indicated on the drawings.

E. All gauges on water lines shall be fitted with pressure gauge snubbers as manufactured by U.S. Gauge Co., Manning, Maxwell and Moore, Inc., The Marshalltown Mfg. Co., H.O. Trerice Co.

F. Pressure gauges on water lines shall have 4-1/2 inch dials.

G. The scale range for pressure gauges shall be 0 to 150 psig.

H. Gauges suspected of being inaccurate shall be tested and replaced if inaccuracy is verified.

2.11 THERMOMETERS AND WELLS

A. Furnish and install, where shown on the drawings and where specified herein, separable well type, industrial thermometers as manufactured by Manning, Maxwell and Moore, Inc., Taylor Industrial Co., Moeller Instrument Co.

B. The thermometers shall have a nine inch scale and a white face with black filled engraved letters. They shall be angle or straight stem type as conditions necessitate.

C. All thermometer wells shall be installed in such a manner that a minimum of restriction will be caused to the flow in the pipes so that the thermometers can be easily read.

D. Install thermometer wells adjacent to each throttling valve and where shown on the drawings and as indicated herein.

E. Where installation conditions necessitate that a thermometer be installed higher than seven feet above the floor a remote bulb dial thermometer shall be installed where directed by the Architect. The thermometers shall have six inch dials and shall be vapor or mercury actuated and shall have separable wells.

F. The scale range for thermometers shall be $30^{\circ}F$ - $240^{\circ}F$.

G. All instrument wells and valved connections for controls and indicators, furnished by the Automatic Temperature Control Subcontractor, shall be installed by this Contractor.

H. Accuracy shall be within 1 percent of scale range. Thermometers suspected of being inaccurate shall be tested and replaced if inaccuracy is verified.

2.12 AIR VENTS

A. Furnish and install a manual air vent with test petcock at each local high point in the water piping mains. Furnish and install a gate valve on the system side of each automatic air vent. The air vents shall be manufactured by Bell & Gossett, Taco, Watts or Armstrong.

Automatic air vents located above hung ceilings shall be fitted with drain piping to floor drain or service sink.

B. Automatic air vents in mechanical equipment rooms shall be piped to condensate drain pans or floor drains.

C. Furnish and install manual air vents for all upfed radiation, each unit heater, cabinet heater and where indicated on the drawings. Furnish and install a petcock on the system side of each manual air vent.

2.13 AIR SEPARATORS

A. Furnish and install air separators for the hot water system where indicated on the drawings. The separators shall be as manufactured by Bell & Gossett, Taco, Thrush.

B. The units shall be of ASME construction and shall be stamped 125 psig W.P.

C. The units shall be complete with integral strainers and collecting screen and 1 inch drain valve.

D. The units shall be of the sizes indicated on the drawings and shall be installed in strict accordance with the manufacturer's recommendations with supplementary steel supports.

2.14 DIRT POCKETS

A. Provide dirt pocket at bottom of each hot water riser and where indicated, not smaller than full size of riser and not less than 12 inches long.

B. Provide in each dirt pocket, 1 inch hose ball valve, with cap and chain.

2.15 FLOW STATIONS

A. Furnish and install venturi type flow stations at each water pump suction or discharge and as indicated on the drawings. The stations shall be used to set proper water quantities in piping. One portable master flow meter set shall be provided. Meter shall become the property of the Owner. The flow stations shall be manufactured by Aeroquip Corporation, BIF or approved equal.

B. Each primary flow element shall be a Venturi selected from manufacturers' engineering data to permit prescribed flow at a minimum head loss. For maximum accuracy and minimal turbulence in recovery area and thus low pressure loss, Venturi's shall have a minimum length of 1.6 x pipe diameter. The beta ratio shall be selected to allow for a differential pressure compatible with the meter as specified herein and insure a properly calibrated system accuracy within 1% throughout the entire range. This accuracy must be obtained with as little as five (5) pipe diameters of straight pipe upstream and two (2) diameters downstream from the Venturi. Each Venturi shall be furnished with two (2) accurately located built-in sensing traps, nipples, shut-off valves and quick connect couplings. Venturi's shall be complete with identification tag on chain, giving pipe size, Venturi series, station identification, and meter reading at specified flow rate, versus differential curves and installation instructions.

C. Venturi stations shall be one-piece bronze threaded 1/2" through 2-1/2". Sizes 3" through 10" shall consist of one-piece cadmium plated cast steel Venturi with weld neck ends.

D. Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20% and 80% of the full scale range on a linear meter (e.g. between 10" and 40" on a 0-50" meter) with permanent pressure loss of not more than 25% of indicated flow rate differential pressure.

E. The indicating meter shall be portable type with 6" round dial, 270 degrees indication. It shall be the dual rupture-proof liquid filled bellows type with integral temperature compensation. The meter shall have over-range protection in either direction equal to the working pressure equivalent of the instrument housing (250 psig at 250 degrees F). The accuracy of the meter shall be no less than 0.5% full scale. The meter case shall be waterproof and coated with appropriate paint. It shall have external zero and range adjusting screws and life long lubrication. Scale shall be calibrated uniformly either in differential pressure (0-50"); percent of flow; directly in GPM.

F. Portable Master Meters shall be mounted in a durable metal reinforced plastic carrying case with the following accessories:

1. Two (2) 10" lengths of connecting hose, each with color coded quick connect couplings compatible with the Venturi coupling.

2. Two (2) brass blow-down valves with Buna-N seals.

3. Blow-down hoses.

4. Instruction book with Flow Vs. Differential curves.

2.16 RADIATION

A. Radiation:

1. Provide hot water perimeter radiation of the size and capacity as shown and scheduled on the drawings and as described. Heat output shall be 800 BTUs per hour per foot minimum.
2. Radiation shall be as manufactured by Slant/Fin, Sterling, Standard Fin Pipe Radiator Corporation, or approved equal.

3. Furnish and install baseboard cover assembly as manufactured by Slant/Fin Corporation, consisting of one-piece bottom, back and top panel, and one-piece front panel, formed of cold rolled steel. Room control damper vane shall be provided for each length of enclosure, and shall modulate fully and freely, yet retain any setting through its arc without protruding knobs, chains or other devices. Damper shall swing in position on damper pivots inserted in dieformed slots at top of support bracket. All cover components shall be painted in shell white, amino modified alkyd polyester finish, based at 500°F. Baseboard cover to be 14 gauge AWG.

2.17 PUMPS

A. General:

1. The water systems will be cleaned and tested with a water treatment as specified hereinafter in this Specification. It shall be the responsibility of this Contractor to coordinate with the Water Treatment Specialist and the pump manufacturer to be assured that the normal life of the pumps and their related parts will not be deteriorated by the water treatment.

2. Shop drawings and complete performance curves for each pump shall be submitted for approval.

3. The pressure drops through various apparatus, which was used in calculating the dynamic head of the pumps, are indicated in the schedules on the drawings. If apparatus with pressure drops other than those indicated are selected and approved, it shall be the responsibility of this Contractor to modify the pump head characteristics accordingly and to furnish pumps with the required capacity. Additional costs caused by revising the pumps heads as described above shall be borne by this Contractor.

4. Pumps shall be as manufactured by Bell & Gossett, Aurora, Weinman or approved equal. Each pump shall be factory tested.

5. Pumps shall be selected so that the operating point on the impeller curve will be within 3 percentage points of the point of maximum efficiency for the impeller selected.

B. In-Line Pumps:

1. Furnish and install as shown on the plans. In-line pumps shall be Taco as scheduled or approved equal.

2. The pump shall be single stage, vertical split case design, in cast iron bronze fitted construction. The pump internals shall be capable of being serviced without disturbing piping connections. The impeller shall be of the enclosed type, hydraulically and dynamically balanced and keyed to the shaft and secured with a suitable locknut.

3. The pump shall employ a mechanical seal, with a carbon seal ring and ceramic seat. A shaft sleeve shall be furnished under the complete wetted areas of the mechanical seal.

4. The bearing frame assembly of the pump shall be fitted with oil lubricated, bronze journal bearings and a hardened alloy steel shaft.

5. A flexible coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor.

6. The motors through 2 HP shall be resilient mounted equipped with oil lubricated journal bearings. 3 HP motor shall be rigid mounted with ball bearings.

7. The pump shall be factory tested, toroughly cleaned and painted with one coat of machinery enamel prior to shipment. A set of installation instructions shall be included with pump at the time of shipment.

2.18 HOT WATER UNIT HEATERS

A. Casing shall be manufactured from heavy gauge steel, phosphatized, baked enamel finished. Finish as approved by Architect.

B. Fan shall be designed and built for high efficiency with aluminum blades, factory balanced.

C. Coils shall be constructed with steel headers. Fins shall be aluminum mechanically bonded to seamless copper tubing. Coils shall be tested at 300 psig air under water.

D. Motors shall be totally enclosed, insulated and with sleeve or ball bearing. All single phase motors shall have built in overload protection. Sleeve bearing motors shall be oiled and ball bearing motors shall be permanently lubricated.

E. Louver fin diffuser shall be used for versatility and provide 4 direction control.

2.19 HOT WATER CABINET UNIT HEATERS

A. Basic unit shall include chassis, coil, fanboard, fan-wheel housing, motor and insulation. Chassis shall be galvanized steel wrap-around structural frame with all edges flanged. Insulation shall be faced, heavy density glass fiber.

B. All cabinet parts shall be cleaned, bonderized, phosphatized and flow coated with baked on primer. Final finish of spray applied baked on enamel approved by Architect.

C. The units shall be free standing or recessed, vertical or horizontal as indicated on drawings. Cabinet shall be of 16 or 18 gauge steel. Unit access shall be provided.

D. Water coils shall be 5/8" OD seamless copper tubes mechanically bonded to configured aluminum fins with continuous fin collars and sleeved coil end supports. Maximum working pressure shall be 300 psig, factory burst test 450 psig (air) and leak test 300 psig (air under water). Supply and return connections shall be on same side of units on all models and sizes.

E. Fan wheels shall be centrifugal, forward curved, aluminum. Fan housing shall be galvanized steel.

F. All motors shall have integral thermal overload protection and start at 78% of rated voltage. Motors shall operate satisfactorily at 90% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. Temperature rise by winding resistance method shall not exceed 60C (shaded pole motors) and 50C (PSC motors) on high speed. All motors shall be factory run tested assembled in unit prior to shipping.

G. Filters shall be removable by horizontal units by pivoting hinged bottom panel and shall be of 3/4" or 1" replaceable media of woven glass fiber with 3/4" or 1" permanent aluminum frame.

H. All units shall be wired in accordance with National Electric Code, Underwriters' Laboratories, Inc. listed. Junction box for motor cord shall be provided.

I. Accessories:

1. Unit levelers shall be refrigerator type bolts, available on vertical models.

2. Recessing flanges of 18 gauge steel for recessing horizontal cabinet into ceiling shall be provided.

3. Tamperproof access doors shall be provided on vertical cabinets.

4. Motor starters shall be isolated from electric power source for maintenance. Thermal overload device shall protect motor. Overload mechanism shall be reset by moving toggel switch to "off" and then to "on" position.

5. Totally enclosed transformers with Class A insulation to step down available power voltage to 115 volts for motor control circuit shall be provided if required. Transformer shall be factory mounted on units.

6. Built-in, factory wired speed switch.

7. Built-in, factory wired adjustable return air thermostat to cycle the fan.

2.20 SHEET METAL ductwork shall be constructed of galvanized steel sheets or aluminum sheets where indicated. Unless otherwise indicated on the drawings or specified herein, sheet metal ductwork shall comply with SMACNA "Low Pressure Duct Construction Standards" and "High Pressure Duct Construction Standards". Ductwork shall be suitable for low or high velocity systems as hereinafter specified. Low velocity systems shall be applied to systems where the range of static pressure existing in the duct is 2 inches water gage or less. The term high velocity systems shall be applied to systems where the range of static pressure existing in the duct varies from 2 inches through 10 inches water gage and where indicated on the drawings. The air velocity in the low velocity system shall be generally 2,000 FPM or less. Unless otherwise

approved, ducts shall conform accurately to the dimensions indicated; duct dimensions indicated on drawings are clear air flow inside diameter duct dimensions, and shall be straight and smooth on the inside, with joints neatly finished. Where aluminum is welded, minimum thickness shall be 16 gage and welding shall be accomplished by the metallic arc or acetylene process. Ducts shall be anchored securely to the structural slab or framing in the building and the method of anchoring and/or fastening shall be detailed on the layout drawings. Ducts shall be so constructed and installed as to be completely free from vibration under all conditions of operation. Supports shall be attached only to structural framing members and concrete slabs. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Where C-clamps are used, retainer clips shall be provided. Friction clamps indicated in Figure 5.2 SMACNA "Low Pressure Duct Construction Standards" shall not be used.

A. Duct Construction:

1. Curved elbows shall have a centerline radius not less than 1-1/2 times the width or diameter of the duct.

   a. Joints for low velocity ducts shall be made substantially air tight, and no dust marks from air leaks shall show at duct joints, or connections to grilles, registers and diffusers. Joints for supply ducts shall be sealed with 3M sealer or hard cast and taped along all seams.

   b. Laps at the joints for low velocity system shall be made in the direction of air flow. Button Punch Snap Lock will not be permitted.

   c. Transformations shall be made with sides pitched not to exceed a maximum of 20 degrees, 40 degrees included angle, for diverging air flow and 30 degrees, 60 degrees included angle, for converging air flow, or as indicated on the drawings. Factory fabricated reducing fittings for low and high velocity systems using round and oval duct sections when formed to the shape of the ASME short flow nozzle need not comply with the maximum included angles specified.

   d. Square elbows, fittings, and branch take-offs for low and high velocity systems shall be designed, constructed and installed as recommended in SMACNA publication, "Low Pressure Duct Construction Standards" and "High Pressure Duct Construction Standards".

   e. Other details of duct construction, casing construction, access doors, hangers, anchors, and supports, duct joints, volume dampers, duct connections penetration of casing, casing curb detail, and hood construction, unless otherwise indicated on the drawings or specified herein, shall be as set forth in the SMACNA publication, "Low

Pressure Duct Construction Standards" and "High Pressure Duct Construction Standards".

2. Duct piercing roof: Flashing, unless otherwise indicated, shall be provided by others and as detailed in the duct manuals referenced herein.

   a. Flashing and counter flashing where ducts pierce roof construction is provided by others as specified under the roofing section of the specifications.

   b. Flashing for curbs is provided by others as specified under the roofing section of the specifications.

3. Dampers: Dampers shall have an accessible operating mechanism. Where operators occur in finished portions of the building, they shall be chromium plated with all exposed edges rounded. Manual volume control dampers shall be operated by locking type quadrant operators. Dampers shall be two gages heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches (30cm). Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand off mounting brackets, bases or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand off mounting items shall be integral with the operator or standard accessory of the damper manufactuer. Volume dampers shall be provided where indicated on the drawings, and as required for system air balancing.

4. Fire dampers shall conform to UL 555. Fire dampers shall be provided for two hour partitions, floors and walls where shown and required in ducts passing through one hour partitions or walls. Fire dampers shall be provided in ducts passing through walls, floors or ceilings of mechanical rooms. Ducts providing service to two or more floors shall be located in a fire rated chase, equipped with fire dampers. Fire dampers shall be automatic operating type approved for the protection of openings in one and two hour fire rated walls and partitions and shall be installed in accordance with the conditions of their approval and the manufacturer's instruction. Hinged or unhinged access doors shall be provided in the ducts to make all fire doors and fire dampers accessible for inspection and maintenance, and shall conform to the requirements of Plate entitled "Fire Damper Access Doors" of SMACNA "Low Pressure Duct Construction Standards". Ductwork in fire rated floor or ceiling assembly system with air ducts that pierce the ceiling of the assembly shall be constructed in conformance with designs in Underwriters' Laboratories, Inc., Fire Resistance Index. Other designs that have been tested by an approved, independent, nationally recognized testing organization and

comply with the requirements set forth in NFPA No. 90A are acceptable. Unless otherwise shown, the installation details given in SMACNA Fire Damper Guide for fire dampers shall be followed except minimum thickness metal for all sleeves provided for fire dampers shall be not lighter than 14 guage. All accessory items associated with the fire dampers such as retaining angles, sleeves, breakaway connections and access doors shall be provided. Stacked blades and damper frame shall not obstruct duct.

5. Duct access doors: Access doors shall be provided at all automatic dampers, fire dampers, smoke dampers, smoke detectors, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown on the drawings shall conform to SMACNA Duct Construction Standards. In the case of heating and cooling coils access doors shall be provided upstream and downstream of the coil. Doors shall be 15 by 18 inches (38 by46cm) unless otherwise indicated. Where duct size will not accommodate this door size, the doors shall be made as large as practical. Doors 24 by 24 inches (61 by 61cm) or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be of the insulated type. Unless otherwise indicated, doors shall so swing that fan pressure or suction holds the door closed.

6. Duct test holes: Holes with patches or threaded plugs in ducts and plenums shall be provided where directed or necessary for using pitot tubes for taking air measurements to balance the air systems. At each of these locations where ducts or plenums are insulated, extension shall be provided with plug fittings.

7. Flexible duct connections: Where sheet metal connections are made to fan or where ducts of dissimilar metal are connected, and at building expansion joints, a flexible material of inorganic elastomeric compound coated glass fabric approximately 6 inches (152.2cm) in width shall be installed. The flexible material shall be securely fastened by zinc coated iron clinch type draw bands for round ducts. For rectangular ducts the flexible fabric locked to metal collars shall be installed using normal duct construction methods.

8. Duct sleeves and framed prepared openings: Duct sleeves shall be provided for all round ducts 15 inches (38cm) diameter or less passing through floors, walls, ceilings or roof and shall be installed during construction of the floor, wall, ceiling or roof. Round ducts larger than 15 inches (38cm) diameter and all square and rectangular ducts passing through floors, walls, or ceilings or roof shall be installed through prepared openings. All square and rectangular ducts passing through bearing walls and partitions shall be installed in sleeves. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Duct sleeves and prepared openings shall be provided for all duct mains and

duct branches. Branch take off connections to grilles, registers, and diffusers shall be in accordance with SMACNA "Low Pressure Duct Construction Standards".

a. Duct sleeves for square and rectangular ducts, shall be fabricated from 20 gage nominal thickness, galvanized sheet steel, unless otherwise indicated. Ducts sleeves for round ducts installed in bearing walls or partitions, black steel pipe, Schedule 30, 40, or standard weight, shall be used. There shall be 1 inch (25mm) clearance between the duct and the sleeve or 1 inch (25mm) clearance between the insulation and the sleeve for insulated ducts, except at grilles, registers, and diffusers.

b. Framed prepared openings for round ducts larger than 15 inches (38cm) in diameter and for all square and rectangular ducts shall provide 1 inch (2.5cm) clearance between the duct and the opening or 1 inch (2.5cm) clearance between the insulation and the opening for insulated ducts, except at grilles, registers, and diffusers.

c. Closure collar of galvanized sheet metal not less than 4 inches (10cm) wide unless otherwise indicated on the drawing shall be provided for exposed ducts on each side of walls or floors where sleeves or prepared openings are provided except where grilles, registers or diffusers are installed. The collar shall be installed tight against the surface. The collar shall fit snugly around the duct or insulation. The sharp edges of the collar installed around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches (38cm) in diameter or less shall be fabricated from 20 gage nominal thickness, galvanized steel. Not less than 4 nails shall be used to attach collars where the opening is 12 inches (30cm) in diameter or less, and not less than 8 nails shall be used where the opening is 20 inches (51cm) in diameter or less. Collars for square and rectangular ducts with a maximum side of 15 inches (38cm) or less shall be fabricated from 20 gage nominal thickness, galvanized steel. Collars for round, square and rectangular ducts with minimum dimension over 15 inches (38cm) shall be fabricated from 18 gage, 0.0516 inch (1.3mm) in nominal thickness, galvanized steel. Collars shall be installed with nails on maximum 6 inch (15cm) centers.

d. Space between the sleeve or opening and the duct or duct insulation shall be packed with fibrous material.

9. Duct supports shall be not less than two 1 inch (25mm) by 1/16 inch (1.6mm) thick galvanized strap iron hangers spaced one on each side of the duct in accordance with SMACNA "Low Pressure Duct Construction Standards". Supports on the risers will allow free vertical movement of the duct.

10. Sheet metal work that extends to the floor shall have its corners protected by installation of corner angles securely fastened over covering. Corners of all air conditioning apparatus shall be protected in a similar manner. Furnish to the Insulation Contractor random lengths of 1-1/2 by 1-1/2 inch, 26 gauge galvanized angles for insulation protection.

11. Sealants and Connections

    a. All ductwork shall have transverse joints sealed air tight with Minnesota Mining EC800 sealer or hard cast.

2.21 REGISTERS AND GRILLES shall be factory fabricated of steel or aluminum and shall distribute the specified quantity of air evenly over space intended, without causing noticeable drafts, air movement faster than 50 FPM (15.2mpm) in occupied zone, or dead spots anywhere in the conditioned area. Registers and grilles shall be as manufactured by Titus, Krueger, Carnes or approved equal. The Contractor shall be responsible for diffusion, spread, drop, and throw. If, according to the certified data of the manufacturer of the proposed units, the size indicated on the drawings will not perform satisfactorily, the units shall be reselected to perform quietly and effectively in accordance with the manufacturer's recommendations. A schedule of all air inlets and outlets shall be submitted indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop for registers. The inlets and outlets shall be sound rated and certified in accordance with Equipment Test Code Standard 1062R2 of Air Diffusion Council in sound power level, decibels reference 10-12 watt, in octave bands 2 through 8. Registers shall be provided with an opposed blade volume controller with accessible key operator. Provide two keys for each type unless otherwise indicated on the drawings, or if standard with the manufacturer an automatically controlled device will be acceptable. After the system is in operation, if drafts, dead spots, or excessive noise are noticeable in the conditioned spaces due to improper selection of type and size of grille or register, the unit shall be changed to the proper size and type without additional cost. Where the inlet and outlet openings are located less than 7 feet (2.2 meters) above the floor, they shall be protected by a substantial grille or screen in accordance with NFPA No. 90A. All registers and grilles shall be factory finished painted with baked on enamel of a color to match adjacent spaces.

A. Registers shall be four way directional control type. However, return and exhaust registers may be fixed horizontal louver type similar in appearance to the supply register face unless otherwise indicated. Registers shall be provided with sponge rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches (15cm) below the ceiling, unless otherwise indicated. Return and exhaust registers shall be located at a minimum of 6 inches (15cm) above the floor unless otherwise indicated. Four way directional control may be achieved by a grille face which can be rotated in four positions or by adjustment of horizontal and vertical vanes.

B. Grilles shall be as specified herein for registers, without volume control damper.

C. Return grilles and registers shall be set at 45° so as to minimize the view through the blades.

1. Blank off baffles shall be provided where indicated on the drawings or as required for draftless air distribution through the blades. Carefully review the drawings and provide double equalizing deflectors or other types of devices as recommended by the suppliers of the diffusers to produce draftless diffusion of air in areas where walls, columns, and beams interrupt the normal diffusion pattern.

2. Air scoops or air volume extractors shall be provided for grilles, registers, and branch takeoffs where required.

2.22 LOUVERS in exterior walls will be provided by the General Contractor.

A. This Contractor shall provide blank-off panels at all unused portions of the louvers.

1. The panels shall be of sandwich construction with 2 inch thick rigid fiberglass insulation between two 18 gauge aluminum sheets.

2. All reinforcing members and stiffeners shall be aluminum. All fasteners shall be stainless steel.

3. The panel facing outside shall be painted two coats of an approved flat black enamel.

4. All joints between the outside wall and the panel shall be sealed with an approved caulking.

2.23 FANS

A. Ceiling Fans:

1. Furnish and install the ceiling exhaust fans as indicated on the drawings and as specified here.

2. The fans shall be as manufactured by Broan, Ventilator Co., Inc. or approved equal.

3. All units shall be certified for sound and air by the Air Movement and Control Association, Inc. in compliance with AMCA Standard 210 and Standard 300 of the AMCA Certified Ratings Program.

4. Outer box and housing shall be fabricated of galvanized steel and shall be acoustically insulated for quiet operation. Unit housing shall be installed to provide accessibility and removal of motor and blowers without removing housing from the system.

Blowers and motors shall facilitate easy take down by removable fasteners. Motors shall be permanently lubricated. Units shall have accessible internal wiring box with receptacle.

5. All accessories used for installation of this model fan shall be of the same manufacturer, unless otherwise indicated.

6. The fans shall have the capacities as scheduled on the drawings and the fans shall be installed in accordance with manufacturer's recommendations.

B. Propeller Fans:

1. Furnish and install propeller fans where shown on the drawngs.

2. Unless otherwise noted on the drawings, the propeller fans shall be heavy duty industrial type, belt driven with fan guard.

3. The propeller fans shall have the capacities listed in the schedule on the drawings.

4. Fans without automatic backdraft dampers shall be provided with electrically motorized dampers.

5. The fan motors shall be provided with thermal overload protection and disconnect switches.

6. The propeller fans shall be as manufactured by Penn, Cook, Peerless or approved equal.

C. Turbine Ventilators:

1. Furnish and install turbine ventilators as indicated on the drawings and as specified herein.

2. Ventilators shall be as manufactured by Uno Ventilator Company or approved equal.

2.24 INSULATION

A. General:

1. Furnish and install covering and insulation of the types hereinafter specified on piping, ductwork and equipment.

2. All sealers, solvents, tapes, adhesives and mastics used in conjunction with the installation of all insulation specified under this section of the specifications shall possess the maximum possible fire-safe qualities available and shall be of a type as approved under NFPA, IRI and FM standards.

3. Insulation shall not be installed on piping or ductwork until it has been tested and proven tight. Adhesives, sealers and

mastics shall not be applied when the ambient temperature is below 40 degrees F.

4. All piping, ducts, and equipment shall be dry and free of dust, grease and other foreign matter before insulation is applied.

5. At all openings in insulation, protect insulation edges with neatly applied metal frames.

6. Neatly butt all edges of insulation.

7. Fill all voids with insulating cement.

8. All longitudinal overlap in exposed work shall be toward ceiling or wall.

9. Insulation on work passing through sleeves or other openings shall be continuous through the sleeve or opening.

10. Where specified thickness of insulation exceeds available thickness, provide insulation in two layers with all joints staggered.

11. Insulation and jacketing, sealers, tapes, adhesives, mastics and other accessories used in conjunction with the installation of insulation shall have a fire hazard rating of not to exceed 25 for flame spread and 50 for smoke developed. All material shall be of types approved under NFPA 90A, Underwriters' Laboratories and by F.I.A.

12. Underwriters' Laboratories, Inc., label or listing, satisfactory test results from the National Bureau of Standards, or certified test report from an approved testing laboratory shall be required to indicate that fire hazard ratings for materials proposed for use do not exceed those specified.

13. Flameproofing treatments subject to deterioration due to the effect of moisture or high humidity, are not acceptable.

14. Armaflex or similar insulating material is not acceptable.

15. Insulation Jackets and Facings

    a. All jackets and facings shall comply with the Fire Hazard Ratings.

    b. Vapor Barrier Jackets and Facings

        1) All vapor barriers shall be sealed and continuous throughout.

        2) All voids shall be filled with insulating cement prior to applying vapor barrier jackets.

B. Piping:

1. All piping herein specified shall be insulated with fiberglass insulation unless otherwise noted.

a. Insulate all hot water piping. Fiberglass shall be 25 ASJ heavy density pipe insulation with a factory applied embossed white Kraft jacket (all service jacket) as manufactured by Owens Corning Fiberglass.

b. Apply pipe insulation to clean, dry pipe with side and end joints butted tightly. Seal lap of jacket and butt strips with a vapor barrier adhesive. Vapor barrier adhesive shall be as recommended by adhesive manufacturer for this application and shall be compatible to vapor barrier jacket so as to form a complete vapor tight system.

c. Fittings, valves and flanges shall be covered with premolded fiberglass fittings of a thickness equal to adjacent pipe insulation. Sections of premolded insulation shall be wired in place. Hot piping fittings shall have an 8 ounce canvas jacket embedded in a fire retardant insulation lagging adhesive Benjamin Foster 30-36.

d. Insulation thickness for piping system shall be as follows:

		Fiberglass ASJ Pipe Insulation Thickness In Inches				
No.	Piping System Types	1" & Less	1-1/4 - 2"	2-1/2 - 4"	5" & 6"	8" & Larger
1.	Hot Water & Cold Water Make-Up Piping	1.0	1.0	1.0	1.5	1.5

e. 3/4" pipe insulation shall be used on 2" mains as needed to fit in 3-1/2" stud walls.

f. Refrigerant piping to be insulated as recommended by refrigeration equipment manufacturer.

C. Air Separators:

1. Air separators shall be insulated with 2" thick calcium silicate blocks wired in place.

2. All joints shall be filled with insulation cement and the entire outer surface shall be covered with a layer of 1" hexagonal mesh wire securely stapled to the insulation. Over the wire shall be applied two coats of Portland cement. The first coat shall be troweled to a smooth finish. The total thickness of the cement shall be not less than 1/2". An eight ounce canvas jacket shall be embedded in a flood coat of fire retardant insulation lagging adhesive Benjamin Foster 30-36.

2.25 PRESSURE REDUCING AND RELIEF VALVES

A. Furnish and install pressure reducing and relief valves for the various water systems as indicated on the drawings. The valves shall be as manufactured by Bell and Gossett, Taco, Watts or equal. The relief valves shall be adjustable type set for 10 psig above operating pressure.

B. All pressure reducing valves shall have a bypass through a globe valve.

2.26 HOT WATER EXPANSION TANK

A. Furnish and install expansion tanks for the hot water system as indicated on the drawings. The tanks shall be as manufactured by Bell and Gossett, Taco, Amtrol Inc. or approved equal.

B. The tank shall be of a size and capacity as indicated on the drawings.

C. The tank shall be of ASME construction.

D. The tank shall be installed in strict accordance with the manufacturer's recommendations.

2.27 HOT WATER BOILERS

A. Furnish and install the hot water boilers. The units shall be constructed, including all components and accessories, in accordance with ASME, Commonwealth of Massachusetts and the City of Boston Codes and requirements. The boilers shall be Model "MR" as manufactured by Hydrotherm Inc. or approved equal.

B. The hot water boilers shall be gas-fired, cast iron modular type. Each boiler module shall be factory-assembled with combination gas valve with intermittent pilot, transformer, atmospheric-type lanced aluminized steel burners, base, absorption unit, hi-limit aquastat, and draft hoods.

C. Each battery of modules shall be equipped with ASME pressure relief valves, temperature and pressure gauges, manual reset hi-limit and a low water cut-off. Insulated steel jackets shall be provided by the manufacturer for assembly into one complete extended jacket for each battery of modules. Each battery for modules shall be provided with supply and return header manufactured by the boiler manufacturer.

D. The cast iron absorption unit for each module shall be constructed for 100 psi working pressure in accordance with Section IV of the ASME Code for Low Pressure Boilers. Construction features shall include horizontal section design to provide zig-zag water flow with maximum heat transfer from deep-ribbed iron surfaces with cast iron push nipples. Cope seal shall be employed between section to provide a permanent gas-tight seal between sections. Sections shall

be held together with draw rods. Each section shall be hydrostatically tested at 250 psi. Complete assembly shall be hydrostatically tested at 150 psi and air tested. Flue collector shall be of same quality cast iron as absorption unit. Absorption unit shall be held to cast iron side plates and lined with high-temperature mineral-fibre insulating panels by mounting clips and bands. Base assembly shall be fire-tested and dielectric tested.

E. Gas control on each module shall be factory-wired, tested and suitable for firing each module individually. Step firing of each module shall be accomplished by firing individual boilers without reducing their thermal efficiency.

F. The boiler manufacturer shall provide the services of factory trained engineers to supervise installation, start-up and adjustment of the units and operating instructions for the Owner's personnel.

G. Outdoor Reset Hot Water Temperature Controller:

1. Furnish and install an electronic boiler and system water temperature controller, electronic sequencer.

2. The boilers will be sequenced by the boiler electronic sequencer to initiate the "low fire" sequence on the lead boiler followed by a "low fire" sequence of the lag boiler. On an increased demand, the lead boiler "high fire sequence" will be initiated, followed by the "high fire" sequence of the lag boiler. On a decreased demand for heat, the reverse will occur.

3. The boiler electronic sequencer will operate the boilers by varying the hot water discharge temperature, as sensed by the remote sensor, in response to outside air temperature. Control shall be designed for use with secondary sensor in outside air to reset control point upward as the outside air temperature drops.

4. Device shall be capable of up to 8 heating stages for multiple boiler application and shall be set to maintain 200^{o}F hot water supply temperature at outside air temperature of 0^{o}F.

5. Device shall be furnished installed with a code gauge steel panel box designed for remote mounting where indicated on the contract drawings. It shall be furnished with all necessary relays, switches, contactors, primary and secondary remote sensors and shall incorporate a lead/lag selection switch for manual selection of the lead boiler.

6. Refer to Sequence of Control under ATC Section of the Specifications.

2.28 BREECHINGS

A. Furnish and install the breechings or flues of the sizes and shapes as indicated on the drawings and as specified herein.

B. The breachings shall be modular prefabricated piping systems that embody flanged joints designed for quick assembly and pressure sealing capability.

C. The expansion joints shall be pressure tight all welded design.

D. The stack shall utilize a high strength load bearing inner pipe with flanged ends. The joints shall be made with bands which shall be sealed during installation to prevent gas leakage.

E. The outer casing shall function as a jacket to maintain a one inch insulating air space and to protect the inner pipe from internal condensation and mechanical damage.

F. Factory supplied parts shall allow the system to be resupported, if need be, with compensation for expansion and contraction to any required height.

G. The inner gas carrying pipe shall be Type 316 stainless steel with a minimum thickness of 0.035 inches for all sizes. The outer jacket of aluminized steel shall retain its low radiant emissivity up to 900 degrees F actual surface temperature. The outer jacket shall surround a one inch insulating air space and shall protect the inner joints and pipe from damage. The minimum material thickness for outer jackets shall be 0.025 inches for 10 inch through 24 inch sizes.

H. Concentricity of individual pipe section construction shall be obtained by multiple tab spacer bands attached to the outer jacket at each end and retained behind the inner flanges. Side loads shall be transferred through the spacer band tabs to the inner pipe. For long service life and minimum heat conduction, the inner Vee Bands shall be of Type 316 stainless steel.

I. The stacks shall be listed by Underwriters' Laboratories, Inc. and shall carry the UL listing mark.

J. The joints shall be properly sealed and each stack system shall be installed in accordance with the manufacturer's recommendations.

K. The flues shall be Model PS as manufactured by Metalbestos or approved equal for natural gas firing.

2.29 STRUCTURE PENETRATIONS

A. Provide sleeves around pipes, ducts, conduits, etc. whenever they penetrate the structure. The space between the penetrating member (insulated or uninsulated) and the sleeve shall be tightly packed with fibrous material the full depth of the penetration and sealed both sides with a non-hardening resilient sealer. The space around the insulated or uninsulated members should be limited to between 1/2 and 1 inch. Should spaces be left outside the sleeve and the building structure shall be closed in to satisfy the limits

described above with materials providing at least the same surface weight as the structure being penetrated.

B. Filler material within the sleeve shall be inorganic mineral or glass fiber. Combustion rating of the filler material shall be not less than the following when tested in accordance with ASTM E84, NFPA Standard 255 or UL No. 723:

Flame Spread Rating	=	25
Smoke Development Rating	=	0
Fuel Contribution Rating	=	20

C. Acoustical sealent for concealed application shall be non-shrinking, non-migrating, non-straining sealant of either non-drying or permanently elastic type, Tremco Acoustical Sealant.

D. Acoustic sealant for exposed application shall be permanently elastic paintable acoustical sealant, either latex, acrylic, or acrylic-latex type, Pecora AC-2.

2.30 VIBRATION ISOLATION

A. Furnish and install vibration isolation equipment to prevent transmission of vibration from all mechanical equipment to the building structure. Unless otherwise specified, all vibration isolation equipment shall be furnished by a single manufacturer and shall be as manufactured by Korfund Dynamics Corporation, Vibration Eliminator Company, Mason Industries or approved equal.

B. The isolation manufacturer shall supply all unit isolators, complete rails, fan and motor bases and structural steel forms for concrete inertia blocks, where called for. Wherever rotational speed is mentioned as the disturbing frequency, the lowest such speed in the system shall be used. All isolation devices shall be selected for uniform static deflections according to distribution of weight.

C. All wiring and other connections to the vibration isolated units shall be made flexible with a minimum 180 degree loop of greenfield in order to avoid restraining the equipment and short circuiting the vibration isolation.

D. Submittal data for isolation equipment shall include detailed calculations showing weight distribution, type, load and deflection of each isolator. Manufacturers' recommendations must be followed.

E. Unless otherwise indicated, all equipment mounted on vibration isolator bases shall have a minimum operating clearance of one inch between the base and the housekeeping pad beneath. Clearance space shall be checked to insure that no scrap, rubbish, hardware has been left to possibly short circuit isolated base.

F. Equipment connected to water piping should be erected on isolators or isolated foundations to correct operating height prior to making

piping connections to avoid misalignment problems. To facilitate this, equipment should be locked-up with temporary shims to final operating height. When full load is assembled and water is in system, isolators can be adjusted to take up load just enough to allow removal of shims.

G. Air handling equipment should be erected on isolators and leveled with fan operating before flexible duct connection is made. Insure that ducting position is in proper alignment and providing proper clearance in proportion to flexible duct connector length.

H. Horizontal Pipe Runs Within Mechanical Room:

1. All horizonal pipe runs within mechanical rooms area shall be isolated from building structure by means of units designed for insertion in rods.

2. Water lines shall be supported by combination rubber-in-shear and spring hangers. The first three hangers nearest equipment connections shall be of the "load transfer" type.

3. All isolators on piping shall be adjusted after the systems have been filled with water.

I. Centrifugal fans shall be isolated with rubber-in-shear or spring unit isolators, designed for the required deflections or efficiencies; furnish and install all necessary rails or bases as required; deflection for all tubular centrifugal fans shall be 1-1/2 inch. Ventilating units shall be isolated to meet the following requirements.

Up to 450 RPM	75% efficiency (3-1/2 max. defl.)
540 RPM to 850 RPM	90%
850 RPM and over	95%

1. Submittals shall show disturbing frequency, required efficiency, design deflection and outside diameter of springs, when pertinent.

J. Isolators:

1. Single rubber-in-shear shall be a molded shaped element designed for 1/2" deflection under the imposed static load. Double rubber-in-shear shall be two elements as described above, assembled in series to provide 1/2" deflection under the imposed static load. Rubber-in-shear isolators shall be properly housed and provided with adequate facilities for bolting.

PART 3 - EXECUTION

3.01 IDENTIFICATION

A. General:

1. All equipment, piping and ductwork, furnished under this Section of the Specification shall be marked for ease of identification as indicated below.

2. Marking shall be done using self-adhering labels applied to clean, smooth surfaces. Where standard stickers designations are not available, stenciling shall be used. All lettering shall be not less than 3 inches in height with sharply contrasted background for ease of identification. Colors shall be in accordance with ANSI standards. Samples of stickers together with color schedules shall be submitted for approval.

B. Equipment:

1. Equipment marking shall be prominently located on normally visible side of equipment. Equipment intended for installation in finished areas shall have markings located behind normally used access panels mounted so as to be readily found.

2. Equipment identification designations shall be taken from equipment schedules as indicated on the drawings.

C. Piping:

1. Piping marking shall be prominently mounted on all piping exposed to view. Marking spacing shall be every 20 feet and at all changes in direction.

2. Piping markers shall indicate the direction of flow with the piping designation taken from the piping legend indicated on the drawings.

D. Valve Tags and Valve Chart:

1. All valves of all description on all piping are to have valve tags attached with brass clips hook or chain to stem or handle of valve and be readily accessible through access panel or door. They shall be in vicinity of identifying marker noted above.

2. Valve tags are to be circular anodized aluminum, color coded type, with color anodized into metal. Tags to be two (2) inches in diameter with numbers not less than 1/2 inch high. Each tag to also bear identifying mark or legend of service not less than 1/4 inch high. All number and identifying service marks are to be heavily engraved on tags.

3. Color coding of tags to match plastic sleeve identifying markers noted above.

4. To match item as made by Seton Nameplate Corp., New Haven, Conn. 06505

5. All numbers of all valves are to be indicated on the record drawings both in plan and riser diagram.

6. All numbers of all valves along with their location and other pertinent data relative to the requiring of opening or closing another valve when any one valve is opened or closed, shall be incorporated into a valve chart or list. This list shall be typewritten in a approved form and submitted with record drawings and maintenance manuals.

E. Motor Control Identification:

1. All electric motors furnished and installed under this Section shall have permanently applied nameplates fabricated of black enameled aluminum with engraved lettering. Size of nameplate shall be a minimum of 2-1/2 inches long by 3/4 inches high as manufactured by Seton Nameplate Co., New Haven, Conn.

2. All nameplates to bear notations or marks that correspond with data in Operating and Maintenance Manuals.

F. Schedule and Charts:

1. Valve schedules and charts shall be prepared showing tag numbers, valve locations and valve service. Valve tag numbers shall be marked upon the record and/or coordination drawings and valve schedules shall be submitted with the record drawings. Two sets of valve schedules shall be framed under glass and mounted where directed by the Owner. Two sets of valve schedules shall be laminated between mylar sheets and turned over to the Owner. Valve lists shall have valve identification number, and valve location.

3.02 CLEANING

A. Cleaning:

1. Upon completion of all piping and sheetmetal work in any area all work specified under this section is to be cleaned and where required, polished and made ready for use. Clean and remove all debris, clean out all piping systems and flush with water. All fixtures are to be cleaned, all trim installed, all protective oil tape or other materials used to protect work are to be removed. Clean out all floor roof area drains, etc. of all construction material. All strainer and steam trap interiors shall be removed, cleaned and replaced. All dirt pockets shall be drained and cleaned. Flushing shall be supervised by chemical treatment specialits.

2. All ducts and air handling units shall be thoroughly cleaned inside and outside and blown out to prevent any debris from damaging fan wheels or debris hanging through registers or diffusers when systems are placed in operation. All temporary connections required for blowing out the systems, cheesecloth for all duct openings, and any other equipment or labor for cleaning, shall be provided by this Contractor. All filters shall be renewed after air handling systems have been cleaned. The entire HVAC system shall be kept clean until final acceptance. Any damage to ceilings by this Contractor or his agents shall be rectified by him at no additional charge to the Owner.

3.03 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Prior to completion of the Contract, provide field and written operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed.

B. All operating equipment installed under this Section shall be placed in operation and shall function continuously in an operating test for a period of two weeks, without shutdown due to mechanical failure or necessity of adjustment. Prior to scheduling the project Final Inspection and after completion of all installation and running equipment and automatic control adjustments, perform air and water balancing and any other work required to place the equipment in complete operating condition to meet all requirements under this specification. During this running test period, deliver to the Owner two complete sets of operating, service, maintenance and replacement data for all equipment which will require operating maintenance or replacement and one copy of this literature shall be available during the instruction of the operating personnel while the other is checked for completeness. The instructions shall be in two sets, each permanently bound in hard cover. Flysheets shall be placed before instructions covering each section. The instruction sheets shall be 8-1/2 inch by 11 inches with large sheets of drawings folded in. During all working hours of the "two week operating test" this Contractor's instruction personnel shall be available for giving field instructions to the Owner's Operating and Maintenance Personnel. This field instruction shall cover operation, maintenance and adjustment of all equipment installed, to the complete satisfaction of the Owner.

C. Sufficient notice shall be given to the designated operating personnel of the Owner in advance of this period. Upon completion of instruction, obtain from such representative(s) written verification that the above mentioned instruction has been performed. Such verification shall be forwarded to the Engineer.

D. Operating Manual: Upon completing the work, provide the Owner with six copies of the approved operating manual containing approved shop drawings, equipment literature, cuts, bulletins, performance charts, and details, equipment and engineering data sheets and

typewritten instructions relative to the care and operation of the equipment, all properly indexed and bound in two hard back three ring binders. The manual shall have the following minimum contents.

TABLE OF CONTENTS

1. Introduction

   a. Explanation of manual and its purpose and use.

   b. Description of all HVAC systems.

   c. Description of motor controls.

   d. Description of temperature control function and sequence for start-up, operation and shut down.

   e. Description of hot water system.

   f. Safety precautions necessary for all equipment.

   g. Illustrations, schematics, block diagrams.

   h. Wiring diagrams.

   i. Installation drawings.

2. Maintenance

   a. Maintenance and Lubricating Instructions.

   b. Replacement Charts.

   c. Preventive Maintenance Recommendations.

   d. Trouble Shooting Charts for Equipment Components and HVAC Systems.

   e. Testing Instructions for each Typical Parts or Components.

   f. Equipment Calibration Instructions.

   g. Systems Draining, Filling and Purging Instructions.

   h. Chemical Treatment Instructions.

   i. Two typed sets of charts indicating equipment tag number, location of equipment, specific equipment service, greasing and lubricating requirements as recommended, lubricant type and intervals of lubrication. Two complete charges of lubricating oil necessary for all equipment shall be furnished.

j. Two typed sets of instructions for ordering spare parts. Each sets shall include name, price, telephone number and address of where they may be obtained.

3. Manufactuer's Literature

a. Pumps, boiler and air handling equipment.

b. Fans.

c. Motors.

d. Motor Controls.

e. Automatic Temperature Controls.

f. All equipment for which shop drawings have been submitted and approved.

3.04 SPECIAL TOOLS

A. Provide any and all special tools recommended by the manufacturer of items furnished, noted as not being commonly available.

3.05 EQUIPMENT PERFORMANCE TESTS

A. After the systems have been completed and before any HVAC system is accepted, test to demonstrate the capacity of the equipment specified to achieve design inside conditions during design outside summer and winter conditions. This Contractor shall retain the services of all his agents at no additional charge to the Owner until design outside conditions are available for conducting this test. Demonstrate adequate general operating characteristics of all equipment during the equipment performance test to the Owner or his representative, through a competent professional experienced engineer who will attest the reliability of results. The performance tests shall cover a period of not less than 2 days for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections, repairs, replacements and adjustments for deficiencies found in the plant as a whole or any of its components during test, shall be made good as necessary to produce specified conditions. This Contractor shall assume full responsibility for satisfactory operation of all parts of the integrated system during test. Typed tabulated data taken during the performance tests that will indicate that the systems produced the required capacity shall be provided. Performance tests shall include the following specific information in the report with conclusions regarding the adequacy of the system.

1. Time, dates and duration of test.

2. Inside dry bulb and wet bulb temperature maintained in each room or space used for and served during the test, employing instruments properly calibrated before the test.

3. Outside dry bulb and wet bulb conditions obtained hourly from instruments properly calibrated and checked with a sling psychrometer.

4. Electrical input and voltmeter and ammeter readings for all electrical motors when operating fully loaded, to insure that nameplate ratings are not exceeded. Furnish all instruments, test equipment, and test personnel required for the tests at no additional charge to the Owner. The report of test shall be submitted in duplicate.

3.06 CERTIFICATES OF APPROVAL

A. Upon completion of all work, furnish to the Owner, in duplicate, certificates of inspection and/or approval from state and local inspection authorities having jurisdiction indicating the installed HVAC system's compliance to their requirements.

B. Furnish to the Owner, in duplicate, notarized letters from the manufacturers of other agencies of the following systems stating that authorized factory engineers have inspected and tested the installation of their respective systems and found them to be in perfect operating condition. All discrepancies and defective materials shall be rectified and replaced before the above requested letters are notarized.

1. Hot water system.

2. All air handling systems.

3. Automatic temperature control.

3.07 TESTING, BALANCING AND ADJUSTING

A. Testing, balancing, and adjusting work shall be performed by firms certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) or by firms qualifying in compliance with subparagraph: Performance. Before any water is introduced into the piping system for any reasons including cleaning and adjusting, flushing, testing and balancing, the water shall be treated and the water quality shall be certified to be non-corrosive by a specialty subcontractor specializing in water treatment as specified in paragraph: CLEANING AND WATER TREATMENT in Part 3 of this section of the specifications. Any material, equipment, instruments, and personnel required for the testing, balancing and adjusting shall be provided by the Contractor.

B. Performance of this work by firms specializing in the testing, balancing and adjusting of heating, ventilating and air conditioning system will be acceptable provided the testing firms shall have submitted adequate documentation to the Owner as to their competence. The testing firm shall have on its staff a registered professional engineer who shall be responsible for the

accuracy of the balancing procedure and test data. All testing and balancing procedures shall be in accordance with the standards of AABC or NEBB and procedures shall be approved by the Engineer prior to testing and balancing. The firm shall provide proof of having successfully completed a minimum of five projects of similar size and scope.

C. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. All air vents shall be plugged or capped after the system has been vented. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenum and casings, and other items specified hereinbefore, have been vacuum cleaned. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

1. Refer to ATC paragraph for coordination with the ATC Contractor during balancing and adjustments.

D. Testing: The Contractor shall submit his proposed testing program to the Engineer at least two weeks prior to the scheduled test to assure agreement as to the personnel and instrumentation required and the scope of the testing program. All tests shall be conducted in the presence of the Engineer or Engineer's representative who shall be given two days notice before any test is to be conducted. Water and electricity required for the tests will be furnished by the Contractor.

1. Water Piping: After cleaning, all water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for a period of time sufficient to inspect every joint in the system and in no case less than 4 hours. Shut-off valves serving autoamtic air vents shall be in the closed position during hydrostatic testing. No loss of pressure will be allowed. Leaks found during tests shall be repaired by rewelding or replacing pipe or fittings. Concealed and insulated piping shall be tested in place before covering or concealing. All equipment which may be damaged during testing shall be disconnected.

2. Low Pressure Ductwork: Even though the duct construction is for low velocity system, the joints shall be sealed for "Class A" classification. The duct system shall therefore be tested for air leakage up to 1-1/2 times the external static pressure, using procedures similar to high velocity systems. Notification shall be given as to the time of testing for witnessing.

a. Test Apparatus

1) The Sheet Metal Contractor shall furnish a source of high pressure air and flow measuring device for the testing of duct systems for leakage.

b. Test Procedure

1) Close off and seal off openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.

2) Start the blower with its control damper closed.

3) Gradually change the motor speed until the duct pressure reaches 1-1/2 times the external static pressure.

4) Hold this pressure for ten minutes. This brief overloading should reveal marginally constructed joints.

5) Reduce the pressure in the duct to maximum design pressure or 2.0 inches w.g. whichever is greater, and survey all joints for audible leaks. Mark each leak and repair after shutting down the blower or source of air. Do not apply a retest until sealants have set.

6) After all audible leaks have been sealed, the remaining leakage shall be measured with the orifice section of the apparatus as follows:

a) Start blower and open damper until pressure in duct reaches design pressure or 2 inches w.g. whichever is greater.

b) The total allowable leakage for the entire system should be no more than one percent of the total system capacity.

c) If the measured leakage exceeds five percent after all audible leaks have been corrected, the leaks shall be located by more careful listening or by feeling along the joint.

d) Even through a system may pass the measured leakage test a concentration of leakage at one point may still result in a noisy leak and shall be corrected in any case.

E. Balancing:

1. Water System Procedures

a. Adjustment: The hot water system shall be adjusted to provide required quantity to or through each component.

b. Metering: Water quantities and pressure shall be measured with calibrated meters.

c. Venturi tubes, orifices, or other metering fittings and pressure gages shall be used to measure water flow rates and balance systems.

d. Systems shall be adjusted to provide the approved pressure drops through heat transfer equipment, including coils, prior to the capacity testing.

e. Where flow metering fittings are not installed, flow balance shall be determined by measuring temperature differential across heat transfer equipment.

f. Measurement of temperature differential shall be performed with the air system, adjusted as described herein, in operation.

g. Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during the tests.

h. Distribution: Adjustment of distribution shall be effected by means of balancing devices including cocks, valves, and fittings and automatic control valves as provided; service valves shall not be used.

i. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

j. Special procedures: Where necessary and after approval of the Engineer, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the test reports.

2. Duct systems shall be balanced to produce air quantities within 5 percent plus or minus of that indicated. Individual air outlets shall be balanced within 10 percent plus or minus of the air quantities indicated on the drawings.

F. Performance Tests: After cleaning, balancing, and testing are completed as hereinbefore specified, each system shall be tested as a whole to see that all items perform as integral parts of the

system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. The capacity tests and general operating tests shall be conducted by a competent experienced engineer. The tests shall cover a period of not less than 7 days for each system and shall demonstrate that the entire system is functioning in accordance with the specifications.

G. Test Data:

1. General: The Contractor shall provide the Engineer with typewritten schedules of readings taken during the balancing and testing operations indicating the required or specified reading, the first reading taken, and final balanced reading for the following items:

a. Fans: Size, type, speed in RPM, outlet velocity in FPM, static pressure in inches of water, air quantity in CFM, and motor load in amperes and input voltage.

b. Air balance

1) Air outlets and inlets: Size, velocity in FPM and air quantities in CFM.

2) Coils: Size, face velocity in FPM; air temperature entering coil and air temperature leaving coil, wet bulb and dry bulb degrees F; water temperature entering coil and water temperature leaving coil, degrees F.

3) Ducts: Size, velocity in FPM, and air quantity in CFM.

c. Pumps: Inlet and outlet pressures, water quantity in GPM and motor load in amperes and input voltage.

d. Control settings: On site settings for all automatic controls including thermostats, safety controls, minimum damper settings, fire safety thermostats, pressure controls, temperature controls, and other similar items shall be provided by the Contractor. The Contractor shall provide the Engineer with four copies of final test reports. Report shall be on recognized forms similar to those of AABC or NEBB.

3.08 CLEANING AND WATER TREATMENT

A. General:

1. After completion of installation, all piping shall be flushed out and left completely free from oil, dirt, and welding shot. All strainer interiors and steam traps shall be removed, thoroughly cleaned and replaced. All dirt pockets shall be

drained and cleaned. The flushing out and treatment shall be done under the supervision of Betz Laboratories, Water Treatment Corporation of America, Barclay Chemical Co. or approved equal.

2. Furnish complete water treatment equipment, piping, chemicals and service to clean and treat the various piping systems as specified herein in a manner which prevent corrosion, scale, slime and algae growth. Equipment, chemicals and service shall be provided by one of the above Water Treatment specialists or approved equal. The approved Water Treatment Specialists shall supervise the installation of the chemical feed equipment and the chemical cleaning and treatment.

B. Service Contract:

1. A contract satisfactory in form and substance shall be executed between this Contractor and one of the above Water Treatment Specialists or approved equal, through its authorized agents, binding the Water Treatment Specialist to furnish supervisory service to assure the proper cleaning and treatment of the piping systems herein described during the life of the service contract. The service contract shall begin at the time of initial fill of the piping systems herein described for any reason, including testing, and shall terminate with the final acceptance of these systems by the Owner.

2. The Water Treatment Specialist shall perform the following functions through its agents:

a. Supervise the initial fill and flushing out of all piping systems to be treated. The flushing out shall be done in accordance with the procedure hereinafter described.

b. Supervise the installation and introduction of all chemical analyzing and feed equipment.

c. Supervise the initial introduction of water treatment chemicals into the systems and the start-up of chemical treatment equipment.

d. Instruct the Owner's operating personnel in the operation of the chemical treating equipment, performance of the control tests and their interpretation.

e. Provide service calls by its agents as required to insure the proper and continuous treatment of the piping system from the time of initial fill to final acceptance by the Owner. In no case shall the frequency of the service calls be less than once per thirty days.

f. Furnish all required chemicals for the proper cleaning and treatment of all piping systems together with all

testing equipment and reagents for field analysis of the water during the life of the contract.

3. It shall be the responsibility of this Contractor to keep the Water Treatment Specialist fully informed as to the progress of the work so that the piping systems can be cleaned and treated as described herein. This Contractor shall provide the services of his personnel to assist and work under the supervision of the Water Treatment Specialist in the cleaning and treating of the systems as described herein.

4. Before actual execution of the contract, a copy of the contract shall be submitted for approval.

5. All service calls shall be confirmed in writing to the Owner so that a complete record of service activities is available for examination by the Owner.

C. Chemical Treatment:

1. Hot Water System

a. A five gallon bypass type shot feeder complete with valves, funnel and relief valve shall be installed around the circulating pumps.

b. The water systems shall be treated with the proper chemicals to protect against corrosion. Chemicals for this system shall not contain materials which shall harm seals or other parts of the system.

D. Cleaning and Flushing:

1. The following procedure shall be considered as minimum preparation for each system and shall be accomplished sequentially as erection progresses and in such a manner as to prevent contamination of any previously prepared section of piping.

2. At the time of initial fill for each system or part thereof, there shall be added not less than 50 pounds per 1000 gallons of contained water, a powder blend of an alkaline detergent comprised of the following ingredients:

Soda Ash	40%
Sodium Silicate Pentshydrate	35%
Sodium Tro-polyphospate	24%
Wetting Agent, Non-ionic	1%
	100%

3. Water containing this detergent shall be circulated for not less than 6 hours at a velocity of not less than 1 foot per second, after which the system shall be rapidly emptied with circulating pumps operating and, wherever possible, simultane-

ously adding or chasing with rinse water. In any case, the systems shall be flushed until neutral to phenolphatalem. After flushing, all strainers shall be removed and cleaned.

4. As soon as possible after completion of the flushing, and with clean water in the systems, the systems shall be treated with chemicals as described herein.

5. When any piping system is disturbed after it has been cleaned and treated, this Contractor shall immediately notify the Water Treatment Specialist, who will supervise recleaning and/or retreatment as required to comply with the intent of this paragraph, "CLEANING AND WATER TREATMENT".

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PART 1 - GENERAL

1.01 REFERENCE

A. The GENERAL DOCUMENTS, as listed on the Table of contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made part of this Section.

B. Coordinate work with that of other Sections affecting or affected by work of this Section and cooperate with such Contractors to assure the steady progress of the Work.

C. Review all drawings and all Sections of the Specifications for provisions therein affecting the work of this Section.

D. Unless otherwise indicated, the reference made in this Specification to "the building" shall denote each building of the project.

1.02 SCOPE

A. The scope of work under this Section, without limiting the generality thereof, includes the furnishing of all labor, materials, equipment, services, and incidentals necessary to complete all ELECTRICAL work in accordance with the intent of the Specifications and the Drawings.

B. The work shall consist of but not necessarily be limited to the following.

1. Incoming underground ductbank system originating 2'-0" inside the property line and terminating at the services end box and main services in the two buildings (Parcel 20A and Parcel SE70-TA). Said serviceS ARE delivered by and shall be coordinated with the Boston Edison Company.

2. Incoming ductbank system for telephone and cable television services to the TWO buildingS (Parcel 20A and Parcel Se70-T1) from a point 2'-0" inside the property line.

3. The two buildings fire alarm systems including interface with the City of Boston Municipal System.

4. Secondary distribution (208Y/120 volt, 3-phase, 4-wire) system throughout the building, for house (common areas) loads, from the distribution panelboard to building service equipment and to panelboards for branch circuits requirements, including connections, cables, raceway systems, wireways, disconnect switches, panelboards, and appurtenances required for a complete system.

5. Secondary distribution (120/208 volt, single-phase, 3-wire) system throughout the building, for dwelling unit services, from the meterbank to each dwelling unit loadcenter.

6. Lighting system including lighting fixtures, panelboards, raceways, wiring, lamps, switches, time clocks, photo-cell controls, switches and appurentances required for a complete system.

7. Temporary lighting and power system shall be provided in conformance with the requirements of Division 1.

8. Motor starters, contactors, disconnect switches and line voltage (120V and higher) control devices including hand-off automatic switches, selector switches, pilot lights and push button stations not furnished as an integral part of Heating, Ventilating, Air Conditioning, Plumbing and other equipment in general required for the operation of the building facilities.

9. Power supply for the elevator including a fused disconnect switch in the elevator machine room, branch feeder wiring, receptacle and switched light in the elevator pit, elevator machine room lighting and power, and telephone power requirements for the elevator cab via half-way boxes.

10. Grounding systems including grounding and bonding of electrical systems and equipment.

11. Raceways systems for the telephone and cable television systems including pull boxes, raceway system and terminal backboards.

12. Telephone and cable television systems cabling from the outlets in the dwelling units to the terminal backboards in the electrical equipment room including cable, outlets, TV splitters, and cable tagging.

13. Sleeves, inserts and supports to be cast or set in place, all core drilling for the passage or support of electrical materials, equipment, and systems.

14. Sealing of raceway systems to prevent the entrance of water into the building, raceway or equipment.

15. Sealing of raceway system sleeves for fireproofing requirements.

16. Access panels required for access to concealed electrical items requiring access.

17. Submittal of list of materials and shop drawings in conformance with the requirements of Division 1.

18. Testing required by the intent of this specification with typewritten data sheets.

19. Interlock wiring indicated on the drawings or hereinafter specified that is required for the operation of mechanical

equipment furnished and installed under the HVAC and Plumbing Sections of the Specifications. Automatic temperature control wiring is not considered a part of interlock wiring and will be provided under Section 15400.

20. The building's fire alarm system including actuating signal devices from the sprinkler and HVAC systems. The system shall be interfaced with the local fire department via the City of Boston connected master box.

21. Building apartment intercom system and dwelling unit signaling system.

22. Coordination with the utility companies and municipal agencies for the incoming electrical, telephone and cable television services. Carry all utility company and municipal agency backcharges as part of this bid proposal.

23. Other electrical systems and equipment required by the Contract Documents for the proper function of the building not specifically indicated above, but referenced or shown on the drawings or referenced under other Sections of the Specifications.

C. Related work by others and included under other Sections of the Specifications:

1. Excavation and backfill -- EARTHWORK.

2. Concrete work -- CAST IN PLACE CONCRETE.

3. Cutting and patching -- UNIT MASONRY.

4. Painting of all equipment and material other than fixtures, distribution board, panelboards, loadcenters, meterbanks and other electrical components that are factory finished -- PAINTING.

5. Elevators furnished under CONVEYING SYSTEMS.

6. Furnishing and setting in place of plumbing equipment motors and equipment -- Section 15400 - PLUMBING & FIRE PROTECTION.

7. Furnishing and setting in place of HVAC motors and equipment -- Section 15500, HVAC.

8. Automatic temperature control system -- Section 15500, HVAC.

1.03 DRAWINGS AND SPECIFICATIONS

A. The drawings are, diagrammatic and are intended to convey the scope of work; indicate the general arrangement of equipment, conduit and the like; and show the approximate sizes of equipment. The drawings shall be followed as closely as practical in laying out work and

verify all spaces in which the work under this Section is to be installed.

B. It is the intent of the contract documents to provide complete operating systems. Omission from the specifications or drawings of any details of construction, installation, materials or specialists necessary for a safely operable system shall not relieve this Contractor of furnishing and installing the materials, fittings or accessories required for the furnishing and installation of complete and operational systems.

C. Modifications of catalog cuts that may be required in the event of conflicts between the performance and description of equipment or material and the implication of manufacturer's catalog number, the performance and description shall govern.

D. Discrepancies between the drawings and specifications shall be referred to the Architect for interpretation before proceeding with the work. If this Contractor proceeds with the work without referring discrepancies to the Architect for interpretation, he shall do so at his own risk and make all changes to meet the Architect's interpretation of the bid documents without requesting additional compensation.

1.04 CODES, ORDINANCES AND REGULATIONS

A. The installation shall comply with the regulations of the National Electrical Code, State of Massachusetts Electrical Code, City of Boston Building Department, National Electrical Safety Code, the requirements of the City of Boston Fire Department and Wire Inspector, and all legally constituted authorities having jurisdiction. Where the drawings and/or specification requirements exceed the requirements of the applicable codes the requirements specified in the contract documents shall take precedence.

B. Materials furnished and all work installed shall comply with the rules and recommendations of the National Fire Protection Association, the National Electrical Code, with all requirements of all city or state agencies having jurisdiction.

1.05 STANDARDS

A. Materials and equipment shall be new and comply with the applicable standards of the following authorities, except where the contract documents prescribe more rigorous qualifications, the documents shall govern:

1. Underwriters' Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association (NEMA)
3. Institute of Electric and Electronic Engineers (IEEE)
4. American Society for Testing Materials (ASTM)
5. American National Standards Institute (ANSI)

6. National Fire Protection Association (NFPA)
7. Insulated Power Cable Engineers Association (IPCEA)
8. Occupational Safety and Health Administration (OSHA)
9. Boston Edison Company
10. New England Telephone Company

B. Materials and equipment shall be listed by the various testing agencies listed above and shall bear the labels of the applicable agencies.

1.06 EXAMINATION OF SITE

A. The submission of a proposal shall be construed as evidence that this Contractor has visited the site and has made a thorough examination of the existing conditions. Claims for labor, equipment or materials required for difficulties encountered, due to the omission of said site visit, shall be bourne by the Bidder.

1.07 SURVEYS AND MEASUREMENTS

A. Horizontal and vertical measurements shall be taken from reference points established by the Architect. Drawings shall not be scaled.

B. In the event of discrepancy between actual measurements and those indicated, notify the Architect in writing and do not proceed with work until written instructions have been issued by the Architect.

1.08 SHOP DRAWINGS

A. Shop Drawings shall be submitted in accordance with the requirements of Division 1.

B. List of shop drawings required:

1. Distribution panelboards, panelboards, loadcenters, meterbanks and associated components.
2. Motor starters, contactors and control devices.
3. Disconnect switches and fuses.
4. Lighting fixtures and emergency battery units.
5. Wiring devices and plates.
6. Fire alarm system.
7. Raceways and fittings.
8. Wire and cables (all systems and voltages).
9. Photo electric controls and time clocks.

10. Device plates.

11. Items not specifically listed above that may be requested by the Architect prior to the formal submission of shop drawings.

1.09 PERMITS AND FEES

A. Give all notices, file all plans and obtain all necessary approvals from authorities having jurisdiction required for the electrical work and for the use of same by the Architect at the completion of construction. All certificates of inspection, test results and approvals shall be turned over to the Owner and Architect prior to the final acceptance of the building by the Architect.

B. Secure and pay for all required permits, inspections and licenses necessary for, and incidental to the installation of the electrical work and the use of such work when completed.

C. Pay all costs incurred for tests to be performed in conjunction with the contract that are necesary for, and incidental to the electrical work when completed as defined in other paragraphs of this Section.

1.10 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be construed as the base or requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval similar equipment of other manufacturers as substitution, provided he complies with the requirements of Division 1. The Architect's decision as to whether the submitted equipment is acceptable shall be final and binding.

B. Changes necessary to accommodate the substituted equipment shall be made at this Contractor's expense, and shall be as approved by the Architect. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.

C. If substitutions are made in lieu of specified lighting fixtures, the form, dimension, design, photometrics and profile of the specified fixture shall be followed.

1.11 SAMPLES

A. Submit samples as requested by the Architect for his approval in accordance with the provisions of Division 1.

B. Submit to the Architect color selection brochures of colors and finishes, where such choices are available from the factory, for the various materials and equipment to be installed under this Contract.

C. Deliver actual samples of fixtures (wired with cord and cap), nameplates, receptacles, switches, other small devices and parts when and as directed by the Architect.

1.12 EQUIPMENT UTILIZATION VOLTAGES

A. Motors 1/2 HP and larger -- 208 volts, 3-phase.

B. Motors less than 1/2 HP -- 120 volts, single-phase.

C. Control voltage for motorized equipment -- 120 volts.

D. Motors NEMA ratings shall be compatible with the utilization voltages listed.

E. Incandescent and fluorescent lighting, receptacles -- 120 volts.

F. Dwelling unit equipment; ranges -- 208 volts, single-phase.

G. Service to house panelboards in the building -- 120/208 volts, 3-phase, 4-wire.

H. Service to dwelling unit loadcenters -- 120/208 volts, singe phase, 3-wire.

1.13 MOUNTING HEIGHTS

A. Electrical equipment shall be mounted at the following heights unless otherwise noted or detailed on the electrical or architectural drawings. Notes on architectural drawings shall supersede those noted on or detailed on the electrical drawings. If the mounting height of any electrical component is questionable, obtain clarification from the Architect before installation.

1. Wall mounted duplex convenience outlets cable television outlets and telephone outlets -- 12 inches above finished floor to centerline unless noted otherwise.

2. Light switches, pushbutton stations, HOA switches, selector switches, and all other toggle or control switches for the operation of heating, ventilating and air conditioning, plumbing, and general building service equipment -- 4 feet above finished floor to centerline.

3. Panelboards and loadcenters for lighting, power, and other auxiliary systems -- 6 feet 6 inches to top of panel above finished floor.

4. Equipment located in all lobbies shall be as detailed on the architectural drawings or as directed by the Architect.

5. Wall brackets shall be as detailed on the architectural drawings or as directed by the Architect.

6. Fire alarm pull stations -- 4 feet above finished floor to centerline.

7. Fire alarm horn and flashing light assembly -- 7 feet 6 inches above finished floor to centerline.

8. Disconnect switches, service switches and individually mounted starters and contactors for the control, operation or isolation of motorized equipment, and electric heating units -- 5 feet minimum to centerline above the finished floor unless otherwise on the drawings or as required to suit field installation conditions and with the permission of the Architect.

1.14 TOOLS AND EQUIPMENT

A. Necessary tools and equipment such as conduit bending machines, staging for erection of conduit, light fixtures, etc. shall be furnished at the jobsite by this Contractor for fabrication and erecting all related equipment covered by this Section.

B. This Contractor shall retain in his possession, and shall be responsible for, all portable or detachable parts and portions of the installation, including keys, locks, adapters, inserts, instructions, drawings and all other devices or materials that are relative to, and necessary for the proper operation and maintenance of all systems until final completion of his work.

1.15 EXCHANGE OF INFORMATION

A. Electrical equipment and material installed in congested or problem areas and not coordinated by this Contractor prior to the installation of same shall be relocated should they interfere with proper installation of equipment and material to be installed under other sections of the Specification.

B. Particular attention shall be directed to the coordination of systems with the equipment and material specified under other sections of the specifications to be installed in the ceiling spaces. Coordinate with the other trades the elevations of all equipment and materials in hung ceilings areas to insure adequate space for the installation of recessed fixtures before the equipment is installed.

C. All information relative to required openings, equipment sizes, sequence of installation and interfacing requirements with other sections of the specifications shall be provided sufficiently in advance to allow for proper planning in the overall construction schedule.

D. The work must be performed so that the progress of the entire building construction including the work under other sections of the specification will not be delayed or interfere with. Materials and equipment shall be installed as fast as construction conditions of the building will permit and shall be installed promptly.

E. Coordinate the routing and termination points of all electrical work with approved shop drawings of other Sections of the Specifications requiring electrical connections to allow for the proper interfacing of same.

F. This Contractor shall conform and coordinate the locations of all materials and equipment specified under other sections of the specification as related to the installation of the electrical system under this Section to avoid conflicts.

G. Ascertain from approved shop drawings of other sections all information relative to electrical work to be executed under this Section for the installation and operation of approved electrical equipment.

1.16 DISPUTES, PRACTICES AND PATENTS

A. The Architect shall be responsible for settling all jurisdictional disputes, labor practices and claims for infringement as related to the work and materials under this Section if such problem should arise.

1.17 OPENING AND AISLES

A. Examine the architectural drawings for the locations of suitable openings and aisles available for the passage of materials and apparatus to be installed under this Section. This Section shall include the responsibility for having the openings left open until the equipment has been properly installed.

1.18 HANDLING OF MATERIALS

A. Receive and accept at the site, properly handle, house and protect from injury and the weather until ready for installation, the following materials.

1. Materials, equipment and apparatus furnished under this Section.

2. Electrical control equipment furnished under other sections of the specifications; and to be installed under this Section.

B. Equipment damaged in the course of handling, installation or test shall be replaced under this Section or repaired to the satisfaction of the Architect without any additional charge.

C. Trailers for storage of electrical materials and equipment shall be provided under this Section. Trailers shall be located in designated staging areas at the site.

1.19 PROTECTION

A. It shall be the responsibility of this Contractor for the maintenance and protection of all materials and equipment provided

during all phases of construction from loss, damage or deterioration until final acceptance by the Architect.

1.20 DAMAGE TO OTHER WORK

A. This Contractor shall be held responsible for and shall pay for all damage to other work caused by his work or workmen.

B. Repairs of such damages shall be repaired or replaced by this Contractor to the complete satisfaction of the Architect.

1.21 RUBBISH REMOVAL

A. Just prior to the completion of the daily work, this Contractor shall remove from the property all rubbish or waste materials belonging to him. Keep the jobsite free from accumulation of waste materials and rubbish.

1.22 INSPECTIONS

A. Work shall not be permanently concealed before inspection and approval by the Architect, and all inspectors and authorities having jurisdiction.

B. Replace any unacceptable, imperfect or condemned material, equipment or workmanship so as to comply with the intent of the Contract Documents and satisfaction of the Architect and Inspection Authorities without extra cost.

C. Work installed under this Contract that is covered before inspection and approval of the appropriate inspecting authority, this Contractor shall pay all costs of uncovering and reinstalling said work. This shall include all underground conduits and Electrical site utilities work included under this Section.

1.23 CERTIFICATES OF APPROVAL

A. Upon completion of all work, furnish the Architect, in duplicate, certificates of inspection or approval from state, federal and local inspection authorities having jurisdiction.

B. Furnish the Architect, in duplicate, notarized letters from the manufacturer of the fire alarm system stating that authorized factory engineers have inspected and tested the installation of the system and found same to be in perfect operating condition. All discrepancies and defective materials, if any are to be rectified and replaced before the above requested letters are notarized.

1.24 GUARANTEE

A. Work under this Section shall be guaranteed free from defects as required under Division 1.

B. Where defective work results in damage to work of other Sections, all such work shall be restored to its original condition by mechanics skilled in the affected trade, at the expense of this Contractor.

C. Standard equipment guarantees offered by the equipment manufacturers for two years or greater shall be in addition to that as requested by this Contractor.

1.25 RECORD DRAWINGS

A. The Contractor shall refer to Division 1 of the Specifications for the requirements and procedures pertaining to the Record Drawings.

1.26 SCHEDULE OF VALUES

A. This Contractor shall submit a breakdown of his contract prices to aid the Architect in determining the value of work installed as the job progresses. The breakdown shall be as follows:

1. Underground duct bank systems to interfacing points for the site utility work.

2. Secondary distribution system throughout the building.

3. Branch circuit work.

4. Lighting systems.

5. Wiring equipment and connections for elevator, HVAC, fire protection and plumbing systems.

6. Fire alarm system.

7. Grounding system.

8. Empty raceway systems for telephone and cable television.

9. Cabling requirements for telephone and cable television.

B. Other items when specifically requested by the Architect.

C. No requisitions will be paid to this Contractor until after the breakdown is delivered to the architect.

1.27 SAFETY PRECAUTIONS

A. Safety regulations established by OSHA shall be maintained throughout the entire construction period of the project.

1.28 CONTRACTOR'S RESPONSIBILITY

A. The undertaking of periodic inspections by the Architect or his representative shall not be construed as supervision of actual

construction nor make either of them responsible for providing a safe place for the performance of work by this Contractor, for visitors to the site or occupants nor make them responsible for omission of any safety device called for by codes, ordinances or by the Specifications of the manufacturers of the equipment supplied. This Contractor shall be responsible for providing a safe building electrically for all workman, visitors and occupants until the building has been accepted by the Architect.

1.29 QUIET OPERATION

A. Electrical equipment shall operate under conditions of load without sound or vibration which is abnormally objectionable for such equipment in the opinion of the Architect. Sound or vibration noticeable outside of the room in which it is installed, or annoyingly noticeable inside its own room will be considered objectionable. Sound or vibration conditions considered objectionable shall be corrected in approved manner at no change in contract amount.

1.30 PAINTING

A. All field painting, except as specified herein, will be included under the Section for PAINTING.

B. After installation, equipment and accessories with factory primed or finished painted surfaces shall be cleaned and bare or marred spots touched up under this Section with the same grade and color paint as applied at the factory.

C. Nameplates on all equipment shall be cleaned and left free of paint.

1.31 MOTORS

A. Motors shall be built in accordance with latest standards of NEMA and as specified. Motors shall be specifically and expressly wound for standard NEMA voltage ratings, and shall be high power factor and high efficiency.

B. Motors shall be tested in accordance with standards of ANSI C50 and conform therewith for insulation resistance and dielectric strength.

C. Motors shall be provided with adequate starting and protective equipment as specified or required and with conduit terminal box of size adequate to accommodate conduits and wires as sized on electrical drawings or as specified under this Section.

D. Capacity shall be sufficient to operate associated driven devices under conditions of operation and load and without overload and at least horsepower indicated or specified.

E. Motors shall be suitable for continuous duty at rated horsepower with temperature rise not to exceed 40 degrees C for drip proof motors, 50 degrees C for splash proof motors, 55 degrees C for

totally enclosed motors. All motors except totally enclosed shall be capable of 15 percent continuous overload without overheating.

F. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except fractional horsepower motors, which shall have slotted mounting holes.

G. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed efficiency, power factor and current characteristics.

H. Motors smaller than 1/2 horsepower shall be capacitor-starter or split-phase type designed for 120 volts, single phase, 60 cycle operation unless otherwise specified.

I. Motors 1/2 horsepower and larger shall be squirrel cage induction type designed for 208 volts, three-phase, 60 cycle operation unless otherwise specified.

J. Motors 20 horsepower and larger shall be suitable for reduced voltage auto-transformer or wye-delta type starting as indicated on the drawings unless noted otherwise.

K. Motors at full load shall have the following minimum efficiency and power factor ratings at 1800 RPM. The ratings listed below shall also be used as a reference point for motors rated at other than 1800 RPM.

	PF	Efficiency
Up to 2HP	79.0	81.0
3HP to 5HP	85.0	84.0
7-1/2HP to 10HP	86.0	89.0
15HP to 30HP	85.0	91.0
40HP to 60HP	87.0	93.0

L. Starters for motors 20 horsepower and larger shall have time delay relays AGASTAT Model #DE-R-12 in the coil circuit to stagger motor starts thereby eliminating excessive inrush current in the electrical system.

M. Motors installed exterior, exposed to the elements, shall be of the weather protective type with encapsulated windings.

1.32 TEMPORARY LIGHT AND POWER

A. Provide temporary light and power in conformance with the requirements of Division 1.

1.33 INTENT

A. It is the intent of the Electricl Section of the Specifications and the Electrical Drawings to call for finished work, tested and ready

for operation. Any apparatus, appliance, material or work not shown on drawings but mentioned in the Specification, or vice versa, or any incidental accessories necessary to make the electrical installation complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered and installed under this section without additional expense to the Owner. Discrepancies or a question of intent shall be referred to the Architect for decision before ordering any materials or equipment, or before the start of any related work, and the interpretations of the Architect shall be final, conclusive and binding.

1.34 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Prior to completion of the Contract, provide operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. Thoroughly instruct the Owner's representatives in the operation of all electrical systems and components to the complete satisfaction of the Owner. Advise the Owner's representatives as to the location of all electrical equipment associated with the various systems.

B. Submit six (6) copies of operation and maintenance data books to the Architect for approval. If the data books do not meet the following requirements, they will be rejected. Data books that are rejected shall be corrected and resubmitted to the Architect.

1. Provide data in book form with rigid covers, 8-1/2 inches by 11 inches, or 11 inches by 17 inches, and a maximum of 2-1/2 inches thick.

2. Provide data on all lighting fixtures, motor starters, contactors, relays, switching equipment, panelboards, loadcenters, distribution panels, meterbanks, fire alarm system, time clocks, photo-control cells and other electrical systems or equipment provided under this Contract.

3. Provide index and thumb tabs for each item or class. Group materials for any one item.

4. Provide the following information as applicable.

a. Identifying name and number.

b. Complete nameplate data.

c. Performance curves and data.

d. As-built wiring and control diagrams.

e. Manufacturer's operating and maintenance instructions.

f. Complete parts list with recommendation for spare parts to be stocked by the Owner.

g. Name, address and telephone numbers of nearest parts supplier and/or service company.

h. Any other important information as pertinent to the particular item.

C. Upon completion of all instruction to the Owner's designated representatives submit to the Architect a completed "Instructions to the Owner" form including all signatures, dates and other pertinent information. The submittal of this form to the Architect is the prerequisite to final payment.

1.35 DEFINITIONS

A. As used in this Section, the following items are understood to have the following meanings:

1. The Architect shall mean the Roxbury Corners Housing Project or their Authorized Representative.

2. The Contractor shall mean the Electrical Trade Contractor performing the work under this Section.

3. Furnish shall mean purchase and deliver to the project site, complete with every necessary appurtenance and support.

4. Install shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.

5. Provide shall mean "Furnish" and "Install".

6. Work shall mean all labor, materials, equipment, apparatus, controls, accessories, and all other items required for a proper and complete installation.

7. Work by others means work not provided under this Section of the Specification but work furnished and/or installed under other Sections of the Specifications within this Contract.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and equipment included under this Part and required for the proper installation and operation of the electrical system shall comply with the applicable requirements of Part 1 of this Section.

2.02 RACEWAY SYSTEMS

A. Raceways (rigid and intermediate metal conduit, non-metallic conduit, flexible metal conduit, liquid tight flexible metal conduit and electrical metallic tubing) shall be a minimum of 1/2 inch trade size.

B. Rigid and Intermediate Metal Conduit, and Electrical Metallic Tubing:

1. Materials shall be high grade mild steel.

2. Exterior coating shall be zinc applied by electro-galvanizing, hot dipped galvanizing, or sheradizing on entire conduit, including threads. Baked clear enamel, lacquer, or zinc chromate coating shall be applied on top of zinc.

3. Interior coating shall be same as exterior coating.

4. Threads (rigid and intermediate metal conduit) shall be protected on both ends of standard length by conduit coupling or by tightly fitted plastic or fibre thread protector.

5. Couplings, elbows and sweeps (rigid and intermediate metal conduit): Only threaded type shall be used.

6. Couplings, elbows and sweeps (electrical metallic tubing): Only compression type shall be used.

7. Cast ferrous fittings shall be malleable iron, hot dip or electro-galvanized, with clear inert final coating, and with smooth, rounded, burr-free throat of smaller diameter than the threads. Cover shall be cast malleable iron with same coating as body and secured with brass or stainless steel screws. Fittings shall be manufactured by OZ/Gedney, Appleton, Crouse-Hinds, Midland-Ross, Pyle-National, Thomas & Betts.

8. Rigid metal conduit and electric metallic tubing shall be manufactured by Triangle/PWC, Wheatland, Republic Steel or Allied.

9. Electrical metallic tubing shall not be installed buried in concrete slabs, on grade or in any wet locations.

D. Flexible Metal Conduit:

1. Flexible metal conduit shall be single strip, continuous, flexible, interlocked double wrapped steel, galvanized inside and outside, forming smooth wiring channel.

2. Flexible metal conduit shall be manufactured by Pyle-National, Triangle/PWC or American Flexible Conduit.

E. Liquidtight Flexible Metal Conduit:

1. Liquidtight flexible metal conduit shall be similar to standard flexible metal conduit described above, except provided with tough inert, watertight plastic outer jacket.

2. Fittings shall be cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushing which threads to interior of conduit spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat as manufactured by OZ/Gedney, Appleton or Thomas & Betts.

3. Liquidtight flexible metal conduit shall be manufactured by OZ/Gedney, American Flexible Conduit, Electri-Flex or International Metal Hose.

F. Non-Metallic Conduit and Fittings:

1. Non-metallic conduit and fittings used for installation in underground duct banks shall be PVC Type II. Non-metallic conduits used for direct burial services in the earth, in or under floor slabs where designated on the drawings or hereinafter specified shall be PVC Schedule 40. Ducts, conduits and associated fittings shall be manufactured by Carlon, Triangle/PWC or Robroy.

2.03 OUTLET, PULL, JUNCTION BOXES AND FITTINGS

A. Each outlet, junction or pull box shall be of the proper type, class and construction to suit the specific conditions encountered.

B. Outlet, pull and junction boxes shall, in general, be as follows:

1. Recessed interior outlet boxes shall be code gauge galvanized steel and shall be of the shapes and sizes to suit their respective locations and installations, and shall be provided with covers to suit their function and installation. Boxes shall be Midland-Ross, Appleton Electric Company, or Raco.

2. Outlet boxes shall be equipped with fixture stud or straps where required. Minimum box size for fixture, wall or switch outlets shall be nominal 4 inches by 4 inches.

3. Cable television wall outlet boxes shall be standard outlet box with bushed coverplate.

4. Telephone wall outlet boxes shall be standard outlet box with modular pin receptacle coverplate.

5. Large junction and pull boxes shall be code gauge minimum thickness galvanized steel with screw-on covers, unless otherwise noted. Box edges shall be square and shall be continuously welded. Provide cable supports for the support of all tiers of cables and conductors within the pull or junction boxes. Large junction and pull boxes shall be manufactured Keystone-Columbia, Lee Products or McKinstry Metal Works.

6. Screws, bolts, nuts and washers used in conjunction with the installation of all junction, pull and outlet boxes shall be of brass, bronze, or stainless steel.

7. Exterior surface mounted outlet and junction boxes shall be of cast metal with threaded hubs, NEMA Type 3R. Killark, Pyle-National, OZ/Gedney or Crouse-Hinds condulet type. Covers shall be cast metal and shall be gasketed raintight exterior type.

C. Locknuts and Bushings:

1. Bushings shall be galvanized malleable iron, threaded type. One inch and larger sizes shall be insulated type, with smooth rounded plastic shoulder cast securely over top of bushing. Grounded type insulated bushings shall have set screw for locking bushing to conduit, and mounting screw bolting solderless lug to bushing and shall be OZ/Gedney Type HBLG, Midland Ross or Thomas & Betts.

2. Provide bushings at all conduit terminations. Secure conduit to boxes and enclosures by means of double locknuts. Provide grounding bushings at all panels and pull boxes.

D. Expansion Fittings:

1. Undirectional Type - Sleeve joining two conduits, one of which telescopes into the sleeve, the other held in a threaded connection, permitting a maximum relative movement of four (4) inches between the conduit ends. Movable joints shall be watertight with insulating bushing on movable conduit end. Connect ends of conduit with bonding jumper. Use for exposed conduits and in hung ceilings. Expansion fittings shall be manufactured by OZ/Gedney Type EX sleeve with Type BJ bonding jumper; Crouse-Hinds Company, or Spring City.

2. Deflection Type - Flexible sleeve with threaded metallic end fittings to receive conduits. Copper braid bonding jumper concealed in sleeve assembly which shall be firmly held together by two stainless clamping bends. Will permit 3/4 inch deflection from normal in any direction. Use for conduit in slab or earth or where other then horizontal changes may be

encountered. Expansion fittings shall be manufactured by OZ/Gedney Type DX, Spring City or Crouse-Hinds Company.

3. Use at expansion joints and on conduits running between separate structures.

4. Install undirectional type with movable conduit end approximately at halfway point in sleeves.

E. Exterior Wall Conduit Seal:

1. Compound sleeve for conduit passing through waterproof foundations. Consists of threaded sleeve and pressure bushing, jointed by external flanged casing. All parts cast malleable iron, hot dipped galvanized. Entire assembly adjustable to fit wall thickness. Pressure bushing bears on internal sealing gland assembly which tightens around entering conduit. Casing provided with double flanges to block seepage and with ears for nailing to concrete form.

2. Close sleeve with temporary seal as soon as installed. After conduit is installed, tighten pressure bushing until gland seal is watertight.

3. Use for service conduits and all other conduits piercing exterior walls underground.

4. Exterior wall conduit seals shall be manufactured by OZ/Gedney Type FSK, or Link-Seal by Thunder Line Corporation.

2.04 WIREWAYS

A. Wireways shall be of the totally enclosed sheet steel type, complete with all fittings, tees, elbows, wire retainers, closure plates, hangers and component parts required for a complete installation.

B. Physical size, length, and internal cross sectional areas of the wireways shall be determined in the field by this Contractor to suit field conditions unless noted otherwise on the drawings.

C. Wireway systems shall be constructed of code gauge galvanized sheet steel with hinged cover. Straight sections of the wireway system shall be constructed of two separate pieces of sheet steel. One piece shall be used to form the sides and top, the other to form the cover. Captive screws, furnished as a part of the wireway system shall be used for sealing at all hinged covers and couplings at straight sections or fittings. The hinged cover shall be of the full length rust proof type.

D. Fittings, elbows, tees and straight sections of the wireway shall be provided with smooth and round edges to protect the wiring from abrasion. All welded seams and joints shall be ground and polished to remove slag and burred edges.

E. Wireway systems shall be provided with 1/2 inch and 3/4 inch concentric knockouts every six inches on center along the top and 1/2 inch, 3/4 inch, 1 inch and 1-1/4 inch concentric knockouts every 6 inches along both sides.

F. Sheet metal posts shall be factory primed with rust inhibiting phosphatizing coating and finished with ANSI No. 61 gray enamel. All hardware shall be cadmium plated to prevent rusting and corrosion.

G. Lengths, connectors and fittings of the wireway systems shall be U.L. listed and bear the Underwriters' Laboratories label. U.L. listing of lengths without listing of connectors and associate components or fittings shall not be acceptable.

H. The wireway system, all component parts and fittings, shall be by one manufacturer and shall be manufactured by McKinstry Metal Works, Lee Products or Keystone-Columbia.

2.05 WIRE AND CABLE - 600 VOLTS AND BELOW

A. Building system wire and cables rated at 600 volts and under shall be as hereinafter specified.

B. Conductors for the wiring of branch circuits, all motorized circuits, auxiliary system wiring and distribution feeder conductors shall be soft drawn copper and shall have a conductivity of not less than 98 percent of the ANSI standard annealed copper. Conductors shall bear the markings of the Underwriters' Laboratories, the AWG size, type insulation, maximum permissable voltage, the manufacturer's name and trade mark and shall be tagged for the year of the awarding of the Contract.

C. Conductor sizes, in general, shall not be smaller than those specified under this paragraph and in no case shall they be smaller than specific conductor sizes indicated or noted on the drawings.

1. Feeder, branch circuit, fixture tap and line voltage control conductor sizes shall be not less than #12 AWG, except #14 AWG conductors shall be utilized within the dwelling units where indicated.

2. Class 1 remote control and signal circuit conductors shall be not less than #14 AWG.

3. Branch circuit tap wiring from the last junction box to a point within the lighting fixtures where connections are made to the actual fixture, wiring shall be the full AWG size of the branch circuit wiring system and in no case shall it be smaller than #12 AWG. Branch circuit wiring passing through the wiring channels of continuous rows of lighting fixtures shall be not less than #12 AWG.

D. Conductor sizes up to but not including #8 AWG shall be of the single strand solid type; conductors #8 and larger shall be of the stranded type.

E. Wire and cables shall be 600V insulated and be as follows:

1. Branch circuit wiring for lighting and power up to and including #10 AWG shall be TW insulated. Branch circuit wiring #8 AWG and larger as well as all distribution and motor branch circuit feeders shall be THW insulated.

2. Fixture wiring shall be Type SF2.

3. Branch circuit wiring from junction boxes to recessed fluorescent fixtures and branch circuit wiring passing through the wiring channels of continuous rows of lighting fixtures shall be THHN.

4. Auxillary system wiring shall be THHN.

5. Branch circuit wiring within the dwelling units, type "AC" cable. Type "NM" cable may be utilized provided it's use is approved, for this building, by the local authority having jurisdiction.

6. Feeders from the meterbanks to the dwelling unit loadcenters, type "AC" cable if not restricted due to conductor size. If restricted by conductor size, wiring shall be THHN installed in appropriately sized conduit. Said conduit shall be sized by this Contractor as required by code and to meet the needs of the indicated wire size.

7. Motor branch circuit wiring shall be THHN and shall be copper.

F. Insulated conductors and cables shall be U.L. listed bear the U.L. label and be manufactured by Anaconda Wire and Cable, Phelps Dodge Corporation, Rome Cable Corporation, General Cable Corporation or Triangle/PWC.

2.06 TOGGLE SWITCHES

A. Toggle switches shall be of the totally enclosed, flush tumbler type of suitable capacity for the intended load and shall be Specification Grade.

B. Toggle switch bodies shall be of the ivory phenolic compound, quiet indicating type with screw type terminals.

C. General lighting switches shall be 1-pole, 2-pole, 3-way or 4-way and be as manufactured by one of the following:

1. Single pole 20A, 120/277V AC rated:

Arrow-Hart	#1991 Ivory
Bryant	#4901 Ivory
P&S	#20AC1 Ivory
Hubbell	#1221 Ivory

2. Two pole 20A, 120/277V AC rated:

Arrow-Hart	#1992 Ivory
Bryant	#4902 Ivory
P&S	#20AC2 Ivory
Hubbell	#1222 Ivory

3. Three way 20A, 120/277V AC rated:

Arrow-Hart	#1993 Ivory
Bryant	#4903 Ivory
P&S	#20AC3 Ivory
Hubbell	#1223 Ivory

2.07 RECEPTACLES

A. Bodies shall be of ivory phenolic compound, unless noted otherwise, supported by mounting yoke having plaster ears and shall be Specification Grade. Receptacles shall be side or back wired with two screws per terminal. All receptacles shall be the grounding type and shall be connected to metal mounting yoke. A terminal shall be provided for ground wire on all receptacles.

B. Receptacles installed throughout the building unless specifically noted otherwise shall be mounted vertically with "U" slot on the bottom.

1. Duplex convenience receptacles 15A, 125V, U-slot grounding type shall be:

Arrow-Hart	#5252 Ivory
Hubbell	#5252 Ivory
P&S	#5252 Ivory

2. Duplex 20A, 120V, 1-phase, 3-wire, U-slot grounding type convenience receptacles shall be:

Arrow-Hart	#5739 Ivory
Hubbell	#5362 Ivory
P&S	#5362 Ivory

3. Single 20A, 250V, 1-phase, 3-wire grounding receptacles shall be:

Arrow-Hart	#5862 Ivory
Hubbell	#5462 Ivory
P&S	#5862 Ivory

4. Duplex 30A, 250V, 1-phase, 3-wire, grounding type convenience receptacles shall be:

Arrow-Hart	#5700 Brown
Hubbell	#9330 Brown
P&S	#5930 Brown

5. Single 50A, 250V, 1-phase, 3-wire, grounding receptacles shall be:

Arrow-Hart	#5709 Brown
Hubbell	#9367 Brown
P&S	#5950 Brown

2.08 DEVICE PLATES

A. Device plates for toggle switches, receptacles, telephone outlets, pilot lights and miscellaneous devices shall be of high-impact thermoplastic material. Plates must be of modern design having rounded edges and corners and be complete with color-matched mounting screws. Plates must be of one design throughout the building and shall conform to UL, CSA, NEMA and Federal Specification WP-455A standards. Engraving, required for GFI protected receptacles, shall be done by plate manufacturer. Plates shall be ivory and similar to Sierra "P" line as manufactured by P&S.

B. Device plates installed on the exterior of the building shall be of the flush vandalproof type with cylinder locking coverplate. One key shall be provided with each coverplate and shall be turned over to an authorized representative of the Owner upon completion of construction. The device covers and adapter frames shall be of the heavy cast aluminum or dull chrome plate brass type with anodized corrosion resistant finish and shall be manufactured by:

Arrow-Hart	#90200-WP Series
P&S	#4600 Series

2.09 PILOT LIGHTS

A. Pilot lights indicated on the drawings for use on 120V circuits, independently or with toggle switches, shall be rated 75W, 125V candelabra base sockets with 6W clear lamps. Pilot lights shall be:

Arrow-Hart	#1711
Hubbell	#427
P&S	#2152

B. Jewels for use with switches controlling motors shall be green; jewels for other purposes shall be red.

C. Neoprene gaskets shall be provided under all device plates containing pilot lamps to act as light seals.

2.10 MISCELLANEOUS GENERAL PURPOSE OUTLETS

A. Special and general purpose receptacles not specifically listed above under Paragraph 2.07 shall be of Specification Grade, brown phenolic compound finish and manufactured by Arrow-Hart, Bryant, P&S or Hubbell. Ampere, phase and the number of poles shall be as noted on the drawings.

2.11 JOINTS, TAPS AND SPLICES

A. 600 Volt Cable:

1. Wire cable connectors for #8 AWG and smaller shall be of the pressure indent type with an insulating cover equal to Buchanan Electric Products. Connections to motor leads shall be made with solderless lugs similar to Burndy Engineering Company.

2. Connectors for connections to lighting fixtures from branch circuit wiring shall either be of the pressure indent type with an insulating cover or of the pre-insulated, permanent pressure, electrical spring connector type encased in a metal housing and insulating cover equal to Buchanan Electric Products or Scotchlock Type "R" of the Minnesota Mining and Manufacturing Company, respectively.

3. Wire and cable connectors for #6 AWG and larger shall be of the bolted pressure type equal to OZ/Gedney Manufacturing Company or Burndy Engineering Company.

4. Copper Cables #1/0 AWG and larger shall be fastened with a connector requiring two (2) bolts.

5. Joints, taps and splices shall be covered with Scotch brand tape #33 or approved equal.

6. Equipment shall be as manufactured by Buchanan Electric Products Company, Burndy Engineering Company, Dossert Manufacturing Company, OZ/Gedney Manufacturing Company, Incorporated, or Thomas & Betts Company.

2.12 FIRE STOP SEALANTS

A. Fire stop sealants used to seal all openings around electrical raceway systems passing through floors and fire rated walls shall be of the fire retardant silicone foam type. The sealant shall be pliable in character capable of adhering itself to the surrounding surfaces within the void being filled. The sealant shall remain in the pliable state permitting normal building vibration and allowing for material expansion and contraction without cracking or crumbling.

B. The sealant shall remain soft and pliable to allow for the removal and/or addition of cables or conduits without the necessity of

drilling holes. It shall adhere to itself perfectly to allow any and all repairs to be made with the same material.

C. The foam sealant shall be capable of being installed by a single tradesman, working from one side of a floor or wall. The chemical components of the foam shall come pre-measured and contained within a single, hand operated, disposable cartridge which is used for mixing and dispensing the foam. The foam shall also come packaged for use with power mixing/dispensing equipment. No special skills or extensive training shall be necessary to operate either the cartridges or the power equipment. Both shall deliver the correct ratio of the two chemical components of the foam without the possibility of error or the necessity of technical supervision.

D. The foam shall expand to surround all the items within the penetration and maintain pressure against the walls of the penetration. The foam shall cure within five minutes and be fire resistant at that time. No heat shall be required to further expand the foam to block the passage of fire, smoke, or water.

E. The foam sealant shall be nontoxic and nonallergenic before and after cure. The cured sealant shall have a density of between 17 and 22 lb/ft. The sealant shall prevent the spread of smoke, fire, toxic gases or water through the sealed openings either before, during or after a fire. The sealant mixture and thickness shall be capable of maintaining the required fire rating of the floor or fire wall into which it is installed as required by the NEC, Article 300-21.

2.13 ACCESS PANELS

A. Furnish access panels for access to all concealed parts of the electrical system that required accessibility for the proper operating and maintenance of the system. The access panels will be installed by the Contractor under the appropriate Section of the Specifications for the surface in which the panels are located.

B. Acoustic tile ceilings do not require access panels but shall be provided with colored tabs for identification of access areas.

C. All access panels shall be located in a workmanlike manner in closets, storage rooms and/or other non-public areas, positioned so that the component can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 inches by 24 inches). When access panels are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

D. Access panels shall be prime painted with cylinder lock and two keys as manufactured by Inland Steel Products Company, "Milcor", Miami Care, Walsh-Nannon-Gladwin, Inc., "Way Loctor" or equal. They shall be as follows, for references:

Dry Wall Surface "Milcor Type DW"

Masonry Construction	"Milcor Type M"
Stucco and Plaster Ceilings and Soffits	"Milcor Type AP"

E. Access panels shop drawings shall be submitted to the Architect for approval.

2.14 RACEWAY SEALS AND SEALING COMPOUNDS

A. Sealing compounds for raceways, ducts and fittings shall be putty-like consistency workable with the hands and shall not harden materially when exposed to air. The compound shall readily adhere to clean surface of fibre, or plastic raceways, concrete mansonry, lead rubber, polychloroprene, polyvinylchloride and common metals. The compound shall have no injurious effects on the materials or the hands of workmen. The compound shall form a seal with the above mentioned materials without dissolving, noticeably changing the characteristics or removing any of the ingredients. The sealing compounds shall be manufactured by Minnesota Mining, Johns-Manville or Dow Corning.

2.15 SUPPLEMENTARY STEEL, CHANNEL AND SUPPORTS

A. Furnish and install all supplementary steel, channels and supports required for the proper installation, mounting and support of all lighting fixtures, and electrical equipment, to be installed under this Contract as required.

B. Supplementary steel, channels, and supports shall be furnished, installed and secured with all fittings, support rods and appurtenances required for a complete support or mounting system.

C. Supplementary steel, channels, rods supports and fittings shall be Underwriters' Laboratories, Inc. listed, be galvanized steel, and be manufactured by Midland-Ross, Unistrut, Power-Strut, T.J. Cope or Chalfant.

2.16 NAMEPLATES

A. Nameplates shall be three-ply black bakelite with 1/4 inch high engraved white letters on the following equipment. Wording of the nameplates shall be in conformance with the respective schedules and notes on the drawings.

1. Secondary distribution panelboards -- nameplates shall be provided identifying each unit adjacent to each overcurrent protective device contained within same identifying the equipment which it protects.

2. Meterbanks -- nameplates shall be provided identifying each dwelling unit being serviced and the main. Said naemplates shall be located adjacent to each overcurrent device.

3. Motor starters -- nameplates shall be provided identifying each unit and the equipment which it protects.

4. Panelboards -- nameplates shall be provided on the exterior of each panel identifying same and located 1/3 of the way down from the top of same.

5. Nameplates shall be provided for each remote operating station, time clock, disconnect switch, pilot light and control device identifying the units controlled or protected.

6. Nameplates shall be provided for all auxiliary system equipment as indicated and included under other paragraphs of this Section.

2.17 GROUND RODS

A. Ground rods shall be 3/4-inch by 10 feet 0 inches long copper clad steel. If sectionalized, ground rods are used, each end of the ground rod section shall be threaded for extensions. Couplings shall be of the heavy gauge threaded bronze type designed to couple the rod sections together. A removable type driving bolt shall also be provided for driving of the ground rods to protect the couplings and rod ends from damage. Couplings and driving bolts are to be from the same manufacturer of the ground rods to be installed.

2.18 TIME SWITCHES AND PHOTOELECTRIC CONTROLS

A. Time switches (clocks) and photoelectric controls for control of lighting fixtures and equipment as shown on the drawings shall be of the heavy duty type with the required ratings and type of operating mechanism as indicated on the drawings. All time switches shall be provided with an internally operable omitting device that will permit the bypassing of the operating mechanism.

B. All time switches, in general, shall be mounted in NEMA 1 enclosures unless specifically noted otherwise on the drawings.

C. Time switches and photo electric controls shall be manufactured by Tork, Paragon or Sangamo.

2.19 DISCONNECT SWITCHES

A. Disconnect (safety) switches shall be of the HD, quick-make, quick-break type with interlocking cover mechanism and provisions for padlocking the switch handle in the OFF position.

B. Disconnect switches shall conform to the industrial standards set forth by NEMA. Disconnect switches shall be Underwriters' Laboratories listed and bear the U.L. label.

C. Disconnect switches shall be of the ampere and voltage ratings shown on the drawings, as required by the National Electrical Code and other applicable Specification Standards.

D. Disconnect switches shall be of the fused and unfused type as indicated and provided with the number of disconnecting poles indicated on the drawings. Except as specifically noted otherwise, all neutrals shall be of the solid type. Disconnect switches installed on the load side of the motor starters and ahead of the motor for multiple lead motors shall have a disconnecting blade for each hot or current carrying conductor.

E. Disconnect switches used in conjunction with motors shall be horsepower rated for the intended load.

F. Disconnect switch enclosures shall be of the proper NEMA type for the intended location as defined by the N.E.C. Disconnect switches shall be code gauge galvanized steel and shall be phosphate coated. The enclosures shall be finished ANSI #61 gray baked enamel.

G. Cable lugs of the proper type and size shall be provided on the line and load side of the disconnect switches.

H. Disconnect switches shall be manufactured by Square D, ITE, General Electric or Westinghouse.

2.20 FUSES

A. Secondary system fuses, rated at 600V or less, shall be Underwriters' Laboratories listed when such listings are published covering the types of fuses being used, and be constructed in conformance with the applicable standards set forth by NEMA and ANSI. Fuses 600V or less shall be manufactured by Bussman, Shawmut, or reliance and shall be as follows:

1. Fuses, except as specifically noted on the drawings or under other Sections shall be of the one time, NEMA J or L, non-renewable cartridge type.

2. Fuses installed in disconnect switches or combination disconnect switch/starter for the potection of motor branch circuits shall be of the dual element, RK-5 series, current limiting, time delay type.

3. Fuses shall be installed with the proper NEMA type mounting clips. Adapters used in conjunction with standard N.E.C. fuse clips for the mounting of current limiting or dual element fuses will not be accepted.

2.21 BRANCH CIRCUIT AND DISTRIBUTION PANELBOARDS

A. General

1. Main and branch busses shall be tin platted aluminum, sized in accordance with Underwriter's Laboratories standards. Unless otherwise noted, full size neutral bars shall be included.

2. Busses shall be rigidly supported and insulated and shall be so designed that branch circuit breakers can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping.

3. Necessary bussing, drilling, and blank plates shall be provided for installation of future circuits when so indicated on the drawings.

4. Screws and bolts used for making connections shall be equipped with lock washers. Riveted bus connections shall not be used.

5. Mains shall be equipped with solderless pressure indent type connectors for copper conductors and shall have means provided to prevent swiveling of connectors for cable size #2 or larger.

6. Busses shall be provided for all active, spares and spaces called for in the panel schedule.

7. Bus bars shall be flat and parallel to the panel cabinet. The phase and neutral bus bars shall be of the fully rated aluminum type with silver or tin-plated contact points. Single or multiple feeder cable terminal lugs shall be furnished with the panelboard to accommodate the panel feeder sizes and quantities shown on the feeder schedules. Subfeed lugs shall be provided in panelboards as indicated on the drawings. The main bus bar and maximum branch circuit capacity of distribution, branch circuit panelboards shall not exceed the following ratings unless specifically noted otherwise on the drawings.

   a. Distribution panelboards -- 1200A main bus bars with 800A maximum branch circuits.

   b. Branch circuit panelboards -- 100A or 225A main bus bars with 100A maximum branch circuits.

8. Boxes shall be minimum of 20 inches wide by 5 inches deep and constructed of code gauge galvanized steel. Trims shall have adjustable trim clamps and catch. Panels shall have provisions for mounting directories on inside of panel door.

9. Back pan or mounting pan on which busses and branches are mounted shall be rigid to properly support the component parts.

10. Distribution panels shall be of the fusible switch type; branch circuit panels shall be circuit breaker type.

11. Fusible switch distribution panelboards shall be of "QMR" type with interlocking cover mechanism and provision for padlocking the switch handle in the off position.

12. Circuit breakers shall have quick-make, quick-break, trip indicating, thermal-magnetic tripping for openings of breakers at the proper lag during overload and on short circuits as

required by the Underwriters' Laboratories. Breakers shall be of the bolted type totally enclosed in individual bakelite case and mounted into the composite panelboard assembly to permit removal of any breaker or breakers without disturbing the mounting of other breakers not to be removed. These breakers shall also be manually operated to the open and closed positions at will. The ON and OFF position shall be indicated on the operating handle of the circuit breakers. Circuit breakers shall be as follows:

a. 120/208V branch circuit panels -- 10,000 symmetrical RMS amperes for all breakers.

b. Circuit breakers used in 120/208V panels, for lighting circuits, shall be UL listed for switching of single pole lighting circuits.

13. Panelboards shall be provided with directories on inside surface of doors. Directories shall identify panelboards and indicate clearly circuit number and description of the associated branch circuit, allow at least three (3) lines for each circuit. Panels shall be keyed alike. Three (3) sets of keys shall be turned over to the Owner's representative prior to the final payment.

14. Each panelboard or distribution panelboard is to be provided with a ground bus.

15. Panels shall be finished ANSI #61 gray baked enamel and shall be as manufactured by Square D, ITE, General Electric or Westinghouse.

2.22 LOADCENTERS

A. Loadcenters shall be Square D type QO. Mains ratings and branch circuit breaker ratings shall be of size and number as indicated on drawings. Loadcenters shall be plug-on type construction. All current carrying parts of the bus assembly shall be plated. Terminals for feeder conductors to mains and branch neutral shall be UL listed as suitable for the type conductor specified. The loadcenter bus assembly shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge steel shall be in accordance with Underwriters' Laboratories Standards No. 67 and No. 50. Fronts shall include door and be provided with a directory for circuit identification. Loadcenter boxes and fronts shall have corrosion resisting phosphate treatment and a gray baked enamel finish. Loadcenters shall be UL listed and meet Federal Specification W-P-115b as Type 1, Class 2.

B. Branch circuit breakers up to 150 amperes shall be Square D type QO, Ql or approved equal. All breakers shall be plug-on type, toggle action with quick-mate, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF" when the breaker is tripped and by VISI-TRIP

indication. The VISI-TRIP indication consists of a highly visible tripped circuit indicator. The indicator is to be protected by a window which seals the breaker case. The VISI-TRIP indicator shall not be visible when breaker is "ON" or "OFF". All multi-pole breakers shall be single operating handle, common trip variety. Branch circuit breakers feeding convenience outlets shall have sensitive, instantaneous trip in order to give "flash protection" for frayed, stranded wire cords. QWIK-GARD circuit breakers with ground fault circuit interrupters shall be used in accordance with the National Electrical Code. Circuit breakers shall be Underwriters' Laboratories listed and meet the requirements of Federal Specification W-C-375B/GEN, Class 1 with a short circuit current equal to 10,000 AIC.

2.23 METERBANKS

A. Multi-metering equipment shall Square D wall mounted EZ METER PAK. All components shall have been tested and Underwriters' Laboratories listed for use as an integral part of the multi-metering system. Installation shall be made as herein specified and shown on the associated electrical drawings.

B. Enclosures shall be constructed of formed and welded code gauge steel. No device disassembly is to be required before mounting. Mounting shall be accomplished by using a separate mounting channel in conjunction with enclosure for vertical support. Final mounting shall be by the use of external mounting fees for attaching to walls. All devices must be bonded together with bolted connections. Meter units shall be provided with individual, removable covers for each meter position. All compartments containing unmetered circuits shall be provided with a sealing means.

C. All components shall be factory assembled and all current carrying parts shall be plated bus bars. Individual units shall be constructed with an integral sliding one bolt joint-pak assembly for a completely bussed meter center. This single bolt is to be a VISI-TITE bolt for tightening without a torque wrench.

D. Meter sockets shall be 4-jaw non-circuit closing type with 5-jaw provisions. Sockets shall be rated 200 ampere continuous duty. Meter socket jaws are spring reinforced and front removable.

E. Two-pole branch circuit breakers for 100 ampere devices, unless as noted, shall be Square D, two-pole, plug-on type QO.

F. Main device and meter/breaker components must be of such design to permit arrangement to allow wiring at the top or bottom in the same assembly. Equipment shall be so arranged as to permit the installation of units with different branch ratings in the same meter center.

G. The meter center shall be Underwriters' Laboratories listed with a short circuit current rating equal to 22,000 AIC.

2.24 MOTOR CONTROL EQUIPMENT

A. Starters, contactors and control devices used for the control of air conditioning, heating, ventilation and plumbing equipment being installed under this contract shall be suitable for operation with the equipment being provided by the respective Trades under other Sections of this specification. Coordinate the exact size and type of starting equipment required with the respective Trades prior to the submittal of motor control equipment shop drawings to the Architect for formal approval. If this Contractor should on his part fail to coordinate with the other contractors in obtaining the above referenced information relative to the types of starters and control circuitry required for each starter; then he, the Electrical Contractor, shall make any and all modifications or changes necessary to the effected starter or control circuitry or replace same with a new unit at his own expense. Motorized equipment used by this Contractor in determining the actual starter sizes, circuit and control configurations shall be taken from approved HVAC and Plumbing Shop Drawings of the equipment to be provided.

B. Equipment installed under this contract shall be of the proper rating for the intended purpose and the electrical characteristics of the building distribution system whether or not specifically indicated on the drawings.

C. Motor starters/contactors and control devices shall be of one manufacturer and shall be Square D, General Electric, Allen-Bradley or Westinghouse.

D. Equipment enclosures shall be finished ANSI #61 gray, and shall be of the proper NEMA type as required by NEC.

E. Magnetic and manual starters/contactors shall be of the size and voltage rating indicated and/or required by HP ratings. Magnetic starters/contactors shall be furnished complete with fused control power transformers and 120V control coil. Starters shall be provided with overload relays in each phase leg and single phase protection. The overload relays shall be of the ambient compensated type. Furnish starters and contactors with minimum of two normally open and two normally closed contacts, one used to maintain control circuit and the others as spares. Other auxiliary contacts and relays shall be added to starters/contactors as required for interlocking and control of HVAC equipment as indicated and as required by respective Contractors of other trades. Select the proper size overload heater for the actual motor furnished and installed in the field.

F. Control power transformers shall be as follows:

1. 100VA for size 1 starter/contactor.

2. 150VA for size 2 starter/contactor.

3. 300VA for size 3 and 4 starter/contactor

G. START-STOP pushbutton stations, selector switches, thermal magnetic switches and HAND-OFF-AUTOMATIC switches and other components as required for control equipment shall be of heavy duty machine tool type. Pilot lights for single speed starters/contactors shall be green "motor running" and red "motor stop". Pilot lights for two speed starters shall be blue "low", green "high speed" and red "motor stop".

H. Termination lugs of the proper rating, sizes and types shall be provided for all cable connections. Refer to the Drawings for the number, type and conductor sizes.

I. Motor thermal overload switches as shown on the drawings shall be of the heavy duty toggle single pole, single throw type with a bi-metal thermal relay suitable for interchangeable heaters. Contacts shall be of the silver butt type under constant spring pressure. A trip free operating level shall be provided to reset the switch when the switch has been tripped due to overload. Said switch shall be provided for all fractional horsepower motor which is not furnished with an integral overload protection.

2.25 LAMPS

A. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

B. Lamps shall be delivered to the project in their original cartons and installed in the fixtures just prior to the completion of the project.

C. Incandescent lamps as required by the fixture manufacturer and/or hereinafter specified shall be inside frosted with minimum lamp life of 2500 hours and be rated for 130V operation unless specifically noted otherwise on the drawings and/or as hereinafter specified.

D. "PAR" and "R" lamps shall be of the spot or flood type and hereinafter specified with a minimum lamp life of 2000 hours and be rated for 130V operation. All "R" lamps shall be ellipsoidal in shape.

E. Quartz lamps shall be of the clear mini-base or diffused "PAR" type as hereinafter specified with a minimum lamp life of 2000 hours and shall be rated for 130 volt operation.

F. High pressure sodium lamps shall have a minimum lamp life of 24,000 hours, be rated for 208 volt operation.

G. Fluorescent lamps of all 430MA ratings shall be of the rapid start, energy savings, deluxe warm white type, having a minimum lamp life of 20,000 hours and be rated for operation on a 120 volt system unless specifically noted otherwise on the drawings and/or hereinafter specified.

2.26 BALLASTS AND TRANSFORMERS

A. Ballasts for fluorescent and HID fixtures shall be suitable for the proper operation of the lamps served. The ballasts shall be designed to serve the total lamp wattage and milliampere ratings of the lamps contained within the fixture, unless a special rating for a fixture is indicated on the drawings and/or hereinafter specified.

B. Ballasts shall be of the CMB/ETL high power factor type and bear the U.L. label.

C. Ballasts shall be suitable for operation on a nominal system voltage of 120V unless specifically noted otherwise on the drawings and/or hereinafter specified.

D. Fluorescent fixtures shall be provided with two lamp ballasts except where single lamp ballasts are required for odd lamp number fixtures. Three lamp ballasts shall not be used and will not be accepted.

E. Ballasts for fluorescent lamps rated at 430MA and under shall be "A" sound rated ballasts for fluorescent lamps. HID ballasts shall be "B" sound rated.

F. Fluorescent ballasts shall be of the watt reducing energy savings type equal to Universal "SLH" containing a thermal protective device that deactivates the ballast if its maximum case temperature reaches 110 degrees C. The thermal protector shall automatically reset when the case temperature drops below 85 degrees C.

G. Ballasts required for operation of other than fluorescent lighting sources shall comply with the acceptable standards for such equipment.

H. Ballasts utilized in exterior lighting fixtures and in unheated areas, shall be of the weatherproof encapsulated type suitable for operation in temperatures as low as $0^{O}F$.

2.27 LIGHTING FIXTURES AND EQUIPMENT FABRICATION

A. Lighting fixtures and/or lighting equipment shall consist of all necessary parts, ballasts and hardware. Fixtures shall be factory assembled to provide a complete and operable luminous element to meet the specifications and approval of the Architect.

B. Metal fixtures and/or fixture parts shall be diecast, extruded, rolled, formed and of other manufactured process to provide the required product and finished elements as indicated. Finished products shall be free of flaws, pits or other irregularities either in production or working of the metal.

C. Lighting fixtures (standard and special) shall be U.L. listed. No exceptions shall be made. Fixture manufacturer shall furnish to the Architect via this Contractor notarized letters substantiating the

validity of the U.L. label on their fixture if required. The letter shall include the U.L. test number and date when fixture was accepted by U.L.

D. The exterior finish (color) of all lighting fixtures designated in the specifications or on the drawings as having a special finish, the color shall be selected by the Architect during the construction period at the time of shop drawings review.

E. Lighting fixtures shall be as listed on the Fixture Schedule. The fixtures listed under each type shall be by the same manufacturer. If it is elected to furnish other than the fixtures manufactured by those specified, then the fixture proposed shall be equal, in every respect, to the product specified, including dimensions, finish, photometric curves, material and operating characteristics. Photometric curves of lighting fixtures submitted for approval shall be from an independent laboratory.

2.28 FIRE ALARM SYSTEM

A. Provide a complete and comprehensive Life Safety System comprised of fire detection, and signalling. Materials and equipment, as described herein shall be in accordance with the requirements of the State Building Code, as required by the City of Boston, Massachusetts, and any other authority having jurisdiction.

B. The equipment provided shall be UL listed for fire alarm use. The equipment furnished under this specification shall be the standard product of one manufacturer who has been engaged in productions of this type of equipment for at least ten (10) years, and has a fully equipped service organization within fifty (50) miles of the installation.

C. All components of the system shall be manufactured by the Autocall Division, Federal Signal Corp. or approved equal. Catalog and model numbers hereinafter are specified, are intended to indicate the type and quality of the design as well as the operating features required.

D. The Fire Alarm Systems shall be the zoned non-coded type. It shall be electronically supervised, common signaling, zone indication, automatic alarm type, operating from manual fire alarm stations, smoke detectors and thermal detectors or fire protection flow valves, Activation of any alarm device will:

1. Annunciate zone of alarm on fire alarm control panel and remote annunciator.

2. Sound all alarm horns and flash all visual fire indicators.

3. Send a common alarm signal to central station via the City of Boston connected master box.

4. Shutdown rooftop make-up air unit.

5. Recall elevator to lobby floor or lowest uninvolved floor.

Any disarrangement of system wiring such as loss of power, opens or grounds shall initiate the audible and visual trouble indicators by zone. The trouble lamp illumination shall be noncancelling except by an actual clearing of the system trouble. The audible trouble signal may be silenced by use of a trouble silence switch.

E. The control unit shall be modular and use solid-state components. Alarm initiating circuits shall meet the requirements of the National Electrical Code 760 for power-limited applications and shall function with up to 100 ohms resistance through alarm initiating device contracts and associated wiring. The control unit shall contain an internal audible trouble signal with silencing switch, system reset switch and lamp test switch along with individual zone LED's for trouble and ground faults. A trouble signal silencing switch shall be furnished, so that faults on the alarm initiating and indicating circuits signals can be silenced independently of each other. When trouble signals are silenced, the trouble signal shall restore to normal conditions automatically without manual restoration of the associated trouble signal silence switch, but only after the trouble condition has cleared. Disconnect switches and LED status lights shall be provided within the control panel to manually disconnect each of the zones from the system and a system switch to disconnect the fire alarm system from the remote control station service.

A common alarm and a common trouble relay shall be furnished. Each relay shall provide a dry form "C" contact wired to terminals.

All field wiring connections shall be made to terminals.

The control unit shall have a circuit for connection to a remote station-polarity reversal circuit. The circuit shall open in the case of a trouble condition and reverse polarity for an alarm condition. Alarm condition shall override the trouble condition.

A switch shall be provided to disconnect the remote station-polarity reversal circuit. An LED shall be provided and will indicate when the circuit has been disconnected.

The control panel shall have the capability to connect to a remote annunciator. The remote annunciator outputs shall be supervised.

The control unit shall have provisions for two supervised alarm indicating circuits. Circuits shall be supervised for opens, shorts or grounds. Each zone in the control unit shall contain an alarm and trouble LED and a zone disconnect switch. Each zone shall have two outputs for connection to a remote annunciator.

The control panel shall be provided with the number of zones as indicated on the drawings.

The control unit shall be Autocall Type MDE.

F. Manual Fire Alarm Stations will be non-coded semi-flush type. Stations will be double action with "Lift to Break" plastic shield. When operated, fire stations will remain mechanically latched until manually reset. Construction will be of rigid metal with raised lettering and clear plastic shield with lettering "Lift to Break-Pull Lever Down". Manual fire stations will be Autocall double-action Type 4051. Double-action stations requiring external hammer to break glass to gain access to actuating lever will not be acceptable.

G. Smoke detectors shall be of the solid-state photo-electronic type and shall operate on the light-scattering, photodiode principle. Detector shall be factory-set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion, the distance between the detector and the fire source, the combustible material, the temperature of velocity of the smoke and whether the fire is in a confined area or open area. To minimize nuisance alarms, detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point.

Detectors shall be listed by Underwriters Laboratories and approved by Factory Mutual under current standards for photo-electric type smoke detectors.

All smoke detectors shall be equipped with self-compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation. The detector light source shall be an LED (light emitting diode).

Detector shall be equipped with a pulsed LED power supervisory indicator. The detector shall be designed to latch into alarm following a 6 to 10 second signal processing delay verifying the continued presence of smoke within the sensing chamber. An alarm shall be indicated by a steady red glow for the LED Indicator. Remote LED alarm indicators shall be located on the hung ceilings below the smoke detector located in the ceiling plenum. Provide as a part of the smoke detector and LED assembly sufficient cable to remotely locate the LED on the ceiling below. The LED cable sets shall be not less than six (6) feet.

A calibrated test feature shall be provided, capable of simulating a maximum acceptable amount of smoke for alarm. The test feature shall provide individual local testing of the detector and shall not require generation of actual smoke within the building.

For ease of maintenance and installation, detectors shall be designed for twist-lock mounting to a separate base assembly having screw terminals for external wire connections.

Smoke detectors shall be Autocall Type 4261-820/802.

H. Single station (120V) smoke detectors shall be similar to system type smoke detectors indicated above, except they shall be non-

system 120 VAC operated and furnished with integral horn and suitable for tandum connection.

I. Duct mounted smoke detectors shall be of the automatic photo-electric type and shall be furnished by this Contractor. The detectors shall operate on the light-scattering, Photodiode principle. Detector shall be factory-set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion, the distance between the detector and the fire source, the combustible material, the temperature or velocity of the smoke and whether the fire is in a confined or open area. Detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point. A visual indication of an alarm shall be given when the normally-pulsed supervisory LED glows continuously. Automatic photo-electronic type smoke detectors will be Autocall Duct Type Smoke Detector 4260-026 with Remote Test Station 4260-052.

J. 1. Heat detectors shall be combination fixed temperature and rate of rise or fixed temperature only. Rate of rise element shall comprise calibrated, moisture proof, trouble free vented chamber with flexible metal diaphragm to close contact when temperature rise exceeds 15°F per minute. Contact shall be rated 3A, 28 V DC. Fixed temperature element shall comprise nonrestorable fuseable alloy element with external heat collector that drops for view when alloy fuses for visual indication of operation. Units shall be enclosed in white low profile dome shell with matching base.

2. Units shall be color-coded to indicate one of the following types:

a. 135°F fixed temperature and rate of rise (Autocall 601, 621).

b. 200°F fixed temperature and rate of rise (Autocall 604, 624).

c. 135°F fixed temperature only (Autocall 603, 623).

d. 200°F fixed temperature only (Autocall 604, 624).

K. The audio-visual alarm indicating device shall be of the semi-flush mounted, horn type with flashing strobe light mounted as a part of a common assembly. The bell shall provide a continuous ring as long as the bell is energized with the strobe light continuously pulsating. The bell shall be a db level of not less than 78 at a distance of 10 feet. The unit shall be rated for 24-volt operation.

The unit shall be Autocall 450-F/V33.

L. The annunciator panel shall be of the non-graphic flush mounted type. The annunciator shall be of modular construction with back-lighted annunciator windows. The annunciator shall be provided

with a module test switch of the key type, lock-in type annunciation and module transfer relays. The annunciator shall be provided with the number of active and spare zones indicated on the drawings for the number of fire alarm zones plus a separate module built into the panel indicating the status of the emergency generator. The status lights for the generating system shall indicate essentially four (4) functions. "Generator Run" when the generator has started and is running; "Generator Fail-Start" when the generator has cranked and failed to start; "Emergency Power" when the transfer switch has transferred and emergency power is available; and "No Transfer" if the transfer switch has failed to transfer. The signals for the generator shall be taken from the generator control panel and automatic transfer switch. Contractor to coordinate the wiring requirements for the proper interfacing and connections of same.

The illuminated windows in the annunciator shall have the identify of all zones and functions silk screened or engraved in same. The enclosure cover shall be of the piano hinged cover type with cylinder lock and minimum trim. The enclosure cover shall be of the piano hinged cover type with cylinder lock and minimum trim. The enclosure cover door and frame shall be of extruded aluminum, finish (color) as selected by the Architect during the processing of shop drawings. Detailed shop drawings of the enclosure shall be submitted to the Architect for approval. The unit shall be Autocall type TLDD modified.

M. Operating power shall be 120V AC.

Standby battery and charger shall be furnished to operate alarm indicating appliances in the event of loss of 120V AC operating power. The batteries shall have sufficient capacity to sound alarms for a period of ten minutes after a 24-hour interruption of 120 V AC. The battery system shall be of adequate capacity to serve the basic requirements of the building plus the added audio/visual alarm devices and detectors to be added as a part of the tenant fit up work.

The batteries and battery charging equipment shall be mounted in the fire alarm control panel or in a separate cabinet located adjacent to same. All cabling and cable lugs for the battery system and between the battery system and the fire alarm control panel shall be provided as a part of the system.

N. The fire alarm master box shall be a Gamewell local-energy type, with Boston Fire Department lock and a telegraph sounder in place of tap bell located as shown on the drawings. The masterbox shall be mounted as a flush unit, using the appropriate backbox and trim by Gamewell. The master box shall be equipped with a micro-switch for the purpose of operating the interior alarm system should the master box be used to initiate the alarm. A #6 cable ground in rigid steel conduit shall be furnished and installed from the grounding terminal of the master box to a 3/4 inch by 10 foot long driven copperweld ground rod.

O. Flow and tamper switches, PIV valve and the dry valve alarm kits will be furnished and installed by the FP Contractor. This Contractor shall coordinate with the FP Contractor to insure that the equipment being provided by them under their phase of the work will be compatible for operation with the fire alarm system being installed under this Contract.

P. Elevator Recall -- the fire alarm system shall be provided with a fire alarm recall feature for the elevators. On activation of the fire alarm system the central control panel shall send a signal to the elevator controllers which shall activate same and return all of the elevators to the First Floor. The relays for the sending of the signal to the elevator controllers shall be located in the fire alarm control panel. Coordinate all work, relays and connections required with the Elevator Contractor.

2.29 APARTMENT INTERCOM SYSTEM

A. General:

1. Furnish and install an Apartment House Electronic Communications System as manufactured and distributed by SESCO, Inc., 60 Walnut Street, Dorchester, Massachusetts. The system shall include vestibule panels, postal release, apartment stations, door release, amplifiers and related equipment.

B. System Operation:

1. Operation of any pushbutton on the vestibule entrance panels by the caller shall sound the signal on the corresponding suitephone and light a light in handicapped units. The tenant may carry on a two-way conversation by the use of on-talk button. After determining the identity of the caller, the tenant may release the suitephone. The system, in general, shall consist of a selective signaling, common voice communications from the vestibules to all apartments.

C. Vestibule Entrance Panel:

1. Panel shall consist of as many call buttons as areas to be called, speaker microphone and appropriate index panel. the unit complete with exterior frame shall be housed in an appropiate metallic flush mounted back box. Panel shall be built in two sections. One section shall include numbered signal pushbuttons with a speaker in the center. The other section shall include a metal framed panel, including an index board bearing rows of plates for printed names and numbers. The speaker panel shall contain provisions for postal lock.

D. Power Supply:

1. The power sypply shall operate from 120 volts A.C. and provide D.C. output for signaling and talking. Unit shall be solid state and contain all circuitry required to accommodate the postal time delay feature.

E. Suitephones:

1. The cordless suitephones shall have the following components: pushbuttons switches (one for door release, one for talk and one for listen). The buttons shall be spring loaded plastic self-wiping switch. The loud speaker shall be 32-1/2", magnet .55 oz. The electronic tone shall be adjustable at amplifier. The unit shall measure 6"H x 5"W and be satin stainless steel and mounted on a two gang device. All lettering shall be engraved and stenciled in red. Suitephone units shall be SESCO Model 101. Suitephone that utilizes three buttons or lever switches shall not be acceptable. Handicapped units shall include a red call placed light.

F. Door Opener:

1. Door opener shall be a constant duty mortize type ED1 and shall replace the lock strike plate in the frame of the door. The unit shall be designed to operate on 16 volts, mounted for either left or right hand openings and be finished in brass under hardware.

G. Amplifier:

1. The amplifier shall be a fully transistorized unit containing a lockable, independent volume control for speech levels. The amplifier shall be designed to mount in the rear of the entrance panel for ease of service and to eliminate tampering. All wiring connections shall terminate on the top panel of the amplifier by way of terminal strips. The amplifier shall contain an adjustable time delay relay which when activated by the postal lock (located in the entrance speaker panel) will operate the security door lock and allow access. The amplifier shall be of intergrated construction frequency response adjusted for the best articulation. The housing shall be of rugged extruded aluminum construction with all electronic components mounted on plug-in printed circuit boards.

H. Guarantee:

1. All components shall be guaranteed for any and all mechanical and electrical defects, except that caused by misuse or abuse for one full years from date of completed installation.

2. Contractor shall be prepared to offer a service contract for maintenance of the system after the guarantee period.

I. Submittals:

1. The Architect through the Engineer shall be supplied with eleven copies of illustrations, specifications, descriptions, engineering data sheets of the equipment to be supplied for approval prior to commencement of any specified work.

2. Contractor shall provide all necessary information for proper efficiency.

   a. Diagrams and engineering data sheets of the equipment.

   b. Necessary information for proper installation, operation and service maintenance.

   c. Two maintenance manuals shall be provided to the Owner upon completion of the installation.

   d. Complete point wiring diagrams shall be submitted as part of the shop drawings detailing all components and the sequence of operation.

PART 3 - EXECUTION

3.01 GENERAL

A. It is the intent of the following sub-sections of this part to describe, in general, the installation requirements and the quality of workmanship required by the intent of this Specification. All major equipment and material shall be specified under Part 2 of this Specification. The installation shall conform to the requirements of the agencies listed under Part 1, Paragraphs 1.04, CODES, ORDINANCES AND REGULATIONS and 1.05, STANDARDS.

3.02 INTERIOR RACEWAY SYSTEMS

A. Provide throughout the building, except those systems, branch circuits and feeders which are indicated to be cabled, a complete raceway system for the installation of feeders, branch circuits, auxiliary system wiring required for the function and operation of all electrical and auxiliary systems specified. The raceway systems shall be complete in every detail and shall consist of all conduit, outlets, pull and junction boxes, fittings, hangers, supports and all appurtenances required to comply with the intent of this specification.

B. Raceways shall be thoroughly grounded and bonded in common. Regulations requiring bonding of conduit around outlet, junction or pull boxes shall be strictly adhered to. Threaded fittings and couplings shall be used for all conduit connections; threadless connectors and couplings shall be prohibited for all rigid steel and intermediate conduit work.

C. Raceways shall be fastened to all sheetmetal boxes and cabinets with two locknuts; one on the inside and outside of each box. Insulating bushings shall be provided as required by the National Electrical Code and other applicable specification standards.

D. Raceways concealed within finished walls, ceilings and floors shall be kept 6 inches from parallel runs of hot water pipes. Exposed raceways shall be supported at intervals of not more than five feet having runs installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling.

E. Turns, wherever required in raceways, shall be made by the use of factory ells and fittings. However, where field made bends are required, due to construction conditions, they shall be made with approved hickey or conduit bending machines. Where a multiplicity of conduits make the same turn, a code gauge steel junction box with removable cover may be used. When junction boxes accommodate more than two separate circuits, each circuit shall be grouped and bound with wire managers. Each feeder, branch circuit and auxiliary system cables shall be tagged in the pull and junction boxes. The tags shall indicate the point of cable origination and termination as well as the intended purpose.

F. Exposed raceways passing through walls or ceilings shall be fitted with chromium plated, spun or split type escutcheons. Pipe sleeves shall extend 3/4 inch above finished floor and be flush in walls, unless otherwise noted. All conduit sleeves passing through floors and fire rated walls shall be returned to the original fire rating of the floor or wall after the installation of raceways in same by means of filling the opening with a foam silicone material.

G. Vertical risers for lighting, power and auxiliary systems shall be properly supported at each floor.

H. The included drawings are, for the most part, diagrammatic and, except where definitely dimensioned, the locations of raceways and raceway systems shall be determined in the field. Concealed runs of raceways in floor slabs and walls shall be as short and direct as possible. Exposed raceways in unfinished areas and above hung ceilings or concealed behind removable panels shall run straight lines parallel to walls, ceilings, beams and columns and with right angle bends or threaded conduit fittings.

I. Crushed or deformed raceways shall not be installed and trapped raceways shall be avoided where possible. However, where traps cannot be avoided, a suitable means shall be provided for draining the raceways. Care shall be taken to prevent the lodgement of plaster, dirt or trash in raceways, boxes, fittings, and equipment during the course of construction. Clogged raceways shall be entirely free of obstruction or shall be replaced.

J. Raceways shall be carefully cleaned, blown and swabbed dry inside before installation of wires and cables. The Architect reserves the right to have all wiring in a raceway or raceways removed for inspection should the presence of moisture or dirt be detached in same at no additional expense. If moisture or dirt is found in the raceway system during the inspection of same, it will be thoroughly cleaned and dired to the complete satisfaction of the Architect at this Contractor's expense.

K. Raceways crossing expansion or control joints shall be provided with suitable expansion fittings or other suitable means shall be provided to compensate for the building expansion and contraction.

L. Wooden plugs inserted in concrete masonry blocks, brick or stud walls for the support of raceways, or pipe straps welded to steel structures shall not be accepted. Raceways shall be secured by pipe straps or shall be supported by wall brackets, wood, toggle bolts on hollow masonry units, expansion bolts on concrete or brick, and machine screws or welded threaded studs on steel work. Securing of raceways to hollow type stud wall or fibreboard construction shall be avoided.

M. Raceways in hung ceilings shall be run on and secured to the primary structural members of ceilings, not to lathing channels or T-bars, Z-bars or other elements which are the direct supports of the ceiling panels. Secure conduit firmly to steel by clips and

fittings designed for that purpose. Maintain at least 1/4 inch air space between conduits and supporting walls. Each conduit in a bank of conduits shall be separately clamped. Supports for large banks of conduits shall be channel iron with U-clamps.

N. Raceways shall be run concealed in the hung ceilngs of the finished areas; exposed on the ceilings in unfinished mechanical/electrical spaces and storage areas where there are no hung ceilings. Not more than two 3/4 inch raceways (maximum trade size) shall cross each other in the floor slab at any one point. Raceways crossing locations in the floor slab shall be approved by the Structural Engineer and Architect prior to the pouring of the floor slab. Relocation of raceway crossing points in the floor slab required by the Structural Engineer shall be made by this Contractor at no additional cost. Raceway systems and outlets for branch circuit wiring shall be installed concealed in all new walls. Exposed raceways and surface mounted outlet boxes on new walls shall not be permitted.

O. Waterproof membrane of the structural floor slabs and foundation walls of the building shall be penetrated only at locations approved by the Structural Engineer and in a manner acceptable to the Architect. Proposed penetration points, size openings and method to be used shall be submitted to the Architect for approval prior to the installation of same.

P. Wiring shall not be pulled into the raceway system until it is mechanically complete in all details. The ends of the raceway shall be tightly plugged to exclude dust, moisture, mortar or plaster while building is under the process of construction. All accessible termination points of the raceway systems shall be properly capped or plugged by means of a plug or plastic cap until such time as a junction, outlet or pull box is installed on same or the raceway is extended to its final termination point.

Q. Provide a 1/8 inch nylon pull cord in all empty raceways. Pull cords shall be continuous from outlet to outlet and box to box. Pull cords pulled into raceways that are not to be activated at this time shall be secured at each terminal location so as to prevent backing into the raceway.

R. Galvanized, rigid metal raceways installed in the earth under floor slabs shall be given two coats of black asphalt paint after being made up and buried in the earth. Underground raceways installed in the earth under the building slab shall be covered by a minimum of 6 inches of earth.

S. Distribution, branch and auxiliary system raceways shall be properly sealed on both termination ends to prevent the entrance of water or other foreign elements.

T. Raceways for wiring, unless otherwise specified shall be as follows:

1. Feeders, mains, branch circuit work and auxiliary system wiring buried directly in the earth -- hot dipped galvanized

rigid or intermediate metal conduit painted with two coats of black asphalt paint. PVC schedule 40 conduit may be used if installed in compliance with the requirements of the NEC and local codes and is acceptable to the local inspection authorities. This Contractor shall provide an equipment ground conductor in all PVC conduits or ducts where used. Ground conductor shall be sized by this Contractor to comply with the requirements of the NEC.

2. Mains and feeders for power distribution shall be galvanized rigid metal or intermediate conduit where installed exposed or above hung ceilings.

3. Feeders for service to the dwelling unit loadcenters from the meterbanks -- armored cable (AC).

4. Branch circuit and auxiliary system wiring in furred and hung ceilings, block or stud walls -- thin wall (EMT) electro-galvanized tubing.

5. Branch circuit wiring in furred or stud walls -- flexible metallic conduit, EMT or armored cable (AC).

6. Branch circuit wiring within the dwelling units -- armored cable (AC) or if allowed by local authority having jurisdiction, non-metallic sheathed cable (NM).

7. Branch circuit and auxiliary system wiring concealed in slab work or pour concrete walls -- hot dipped galvanized rigid or intermediate metal conduit. EMT shall not be used in poured slabs or walls.

8. Branch circuit and auxiliary system wiring installed exposed -- Intermediate conduit or EMT in conformance with the N.E.C. and the requirements of other Specification Standards relative to the locations and conditions encountered. EMT shall not be used in any damp or wet locations.

9. Connections to portable equipment from junction boxes and connection of raceways to motor conduit terminal boxes -- liquidtight flexible metal conduit with a maximum length of 18 inches and a minimum length of 12 inches.

10. Flexible taps from junction boxes above hung ceilings to recessed fluorescent lighting fixtures shall be in flexible metal conduit. Length of flexible metal conduit from the junction boxes to the recessed lighting fixtures shall be 6 feet 0 inches long.

3.03 OUTLET, PULL AND JUNCTION BOXES

A. Furnish and install as an integral part of the raceway systems all outlet, pull and junction boxes required for the proper installation of all components of the electrical systems.

B. Outlet, junction and pull boxes shall be of sufficient volume and physical configuration to accommodate the number of conductors entering and leaving the box as well as any splices or connections that may be made within same. Outlet and junction boxes shall also be of schedule volume and physical configuration to accommodate all wiring devices mounted within or on same as well as the number of conductors, splices or connections to be made within same as indicated above.

C. The locations of all wall switch boxes shall be coordinated with the Architect before installation of same. All switch boxes, unless specifically noted otherwise on the drawings, shall be on the swing side of the door for all single doors and on the right hand wall for all double doors.

D. Location of outlets shown on drawings are approximate. Study of the building plans in relation to the spaces and equipment surrounding each outlet so that receptacles, switches, lighting fixtures, devices or other electrical components are symmetrically located and mounted in or on the walls, ceiling and floor. Receptacle boxes have been carefully located within the dwelling units to comply with the NEC (Article 210-52).

E. Outlet, junction or pull boxes, shown on the drawings, that interfere with the installation of mechanical equipment, structural or architectural features or that will be inaccessible due to the work of other trades shall be relocated accordingly, at no additional cost.

F. Outlet, pull and junction boxes shall be properly sealed during the course of construction to prevent the entrance of dirt and foreign materials within the same or the raceway system of which it is a part. Provide temporary covers for all open boxes. Paper may be solidly packed in standard work boxes to prevent the entrance of dirt and foreign materials, in lieu of coverplates.

G. Outlet, junction or pull boxes that are not specifically shown on the drawings but are required for the proper installation of the electrical system shall be installed so that they do not interfere with the structural or architectural features and the installation of materials by the other trades.

H. Reasonable changes in the location of outlets, pull or junction boxes requested by the Architect, prior to roughing, shall not involve additional expense.

I. Outlet, pull and junction boxes shall be installed in a rigid and satisfactory manner and shall be supported by bar hangers in frame construction or shall be fastened directly with wood screws on wood, bolt and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on metal. All outlet, pull and junction boxes shall be supported from the building structure independent of the raceway system. A space of 1/4 inch shall be maintained between exposed

surface mounted boxes and walls. All outlet, junction and pull boxes shall be supported from the building structure independent of the raceway system.

J. Outlet, pull and junction boxes shall, in general, be as follows:

1. Exposed, surface and pendant mounted boxes or boxes installed in normally wet locations shall be of the cast metal type with threaded hubs.

2. Recessed boxes for non-hazardous locations shall be of the pressed sheet steel, zinc coated, cadmium plated type.

3. Outlet or junction boxes shall not be less than 1-1/2 inches deep, unless shallower boxes are required by structural conditions and are specifically approved by the Architect.

4. Ceiling and bracket outlet boxes shall not be less than 4 inches octagonal except that smaller boxes may be used where required by the particular fixture to be installed. Flush or recessed fixtures shall be provided with separate outlet boxes where required by the fixture terminal temperature requirements.

5. Floor outlet boxes shall be of the adjustable watertight type, single or multi-outlet, as required, complete with coverplate to accommodate the devices as indicated on the drawings.

6. Pull and junction boxes shall be constructed of code gauge galvanized sheet metal, of not less than minimum size required by the N.E.C. or other applicable specification "standards" and shall be furnished with screw fastened covers. Boxes exceeding 48 inches in any direction shall be properly reinforced with angle iron stiffeners.

7. Flush mounted ceiling and wall outlets boxes shall be provided with the proper type extension rings, tile and plaster collars required to set flush, with the finished surfaces of the ceiling or walls.

8. Pull boxes used to house both line and low voltage systems shall be provided with internal barriers to separate the systems. The barriers shall be of code guage steel and shall comply with the requirements of the NEC and local codes.

3.04 FEEDER, BRANCH CIRCUIT AND AUXILIARY SYSTEM WIRING

A. Provide throughout the building in the raceway system, except as noted otherwise; all feeder, branch circuit and auxiliary system wiring required for the function and operation of all electrical and auxiliary system specified. The entire installation shall conform to the intent of the requirements of this specification and shall be installed in compliance with all referenced specification standards.

B. Branch circuits, sub-feeders and feeders, are, in general, 3-phase, 4-wire, with one neutral conductor serving as "common". Where 4-wire circuits are used, one of the phase wires shall be connected to each phase of phase supply mains in order to assure a balanced condition in that circuit and proper load balance on the panelboard. Circuit numbers assigned on drawings are used for convenience only and need not necessarily designate the circuit on the distribution panelboard or panelboard to which the circuit may be connected.

C. Branch circuit, sub-feeder and feeder neutral conductors shall be full capacity unless specifically noted otherwise on the drawings.

D. Conductors or cables shall not be pulled into the raceway systems until all work which could cause injury to the conductors or insulation has been completed. A lubricant shall be used when necessary for the pulling of conductors and cables into the raceway systems.

E. Wire and cables shall be carefully handled during installation so as to avoid kinks, twists, and mechanical injury to the conductor, insulation or covering.

F. Where conductors are to be connected directly to devices with the use of terminal screws, such as at light switches, receptacles, and other wiring devices or screw type terminations, the wires shall be formed into a loop to fit around the screws in a clockwise direction so as to be tightly locked in place with same.

G. At no time shall more than one conductor terminate under one thermal screw.

H. Insulating compounds, unless indicated or specified otherwise, for cable joints, boxes, terminals, and other similar items, shall have a bituminous base and shall be free from granular content, creosote alkali, acid, sulphur and water.

I. Feeders, branch circuit wiring and auxiliary system wiring passing through pull or junction boxes shall be individually grouped and bound with wire managers. The conductors in each pull or junction box shall be properly tagged to clearly indicate their electrical characteristics, circuit number and panel designation. Cables shall be supported on suitable racks within the boxes and arranged in an orderly manner. The tags shall be of flameproof, non-conducting material and shall be attached to the conductors by means of a nylon cord.

J. Conductors shall be provided with identification markers at their terminal points. The markers shall be of flameproof cloth, vinyl plastic or aluminum foil with preprinted numbers. Conductor terminal tags for line voltage conductors shall be black numerals on white; conductors for all low voltage and auxiliary system conductor terminals shall be black letters on yellow.

3.05 FUSES

A. Furnish one complete set of fuses in all fusible type equipment, including the distribution panelboards and other fusible type disconnecting devices or switches as specified within this Specification, as shown on the drawings, as required by the N.E.C. and other applicable specification standards.

B. Furnish to the Architect at the completion of construction and before final acceptance of the building, one complete set of three (3) fuses for each different size and type of fuse installed in the building under this Contract.

C. Furnish and install a wall mounted fuse cabinet in the main electric room. Cabinet to contain one complete set of three (3) fuses for each different type of fuse utilized in the building. The fuse cabinet is to be provided with a built in lock. Keys for the cabinet shall be turned over to the Architect upon completion of the construction project.

3.06 GROUND SYSTEM

A. Equipment and systems installed and connected under this Contract shall be bonded and grounded in accordance with the standards of the latest National Electrical Safety Code, the National Electrical Code, and all State and local regulations as a minimum. Grounding and bonding requirements hereinafter specified or indicated on the drawings that exceed the requirements of the agencies indicated above shall be adhered to.

B. Furnish and install all material required for the grounding and bonding in the building, of all equipment, power and lighting systems, all as shown on the drawing or as specified as a minimum.

C. Continuity between all metallic and non-metallic raceways and equipment shall be maintained. Where non-metallic raceways are used in whole or as a part of a raceway system, equipment ground cables shall be extended from terminal point to terminal point and properly bonded. The raceway ground cable shall be TW insulated for branch circuit wiring systems; THW insulated for feeders. Insulated of the proper AWG conductor size to comply with the requirements of the N.E.C. and other governing agencies. Unless specifically noted otherwise, the equipment grounding conductor shall be copper. Where raceways cross expansion or control joints expansion fittings used shall include suitable bonding jumping to insure continuity of the grounding system.

D. Grounding conductors shall be, in general, as follows:

1. A minimum capacity of 15 percent of the rated capacity of the feeder to the equipment it grounds, unless otherwise indicated or required by the N.E.C. Refer to the drawings for the size of the main secondary ground conductor.

2. Minimum size of grounding conductors shall be not less than No. 14 AWG copper.

3. Grounding cables in non-metallic raceways shall have green colored insulation. Increase size of raceway if necessary to accommodate grounding wire.

4. Install grounding conductors in same raceway as phase conductors. Bond at each end of raceway, if necessary, to accommodate grounding wire.

5. Inaccessible and permanent connections shall be of the exothermic type.

6. Bolted connections shall be of the multiple bolt type, 2 bolts, washers and stop nut material -- high copper alloy, brass or silicon bronze. Ferrous hardware shall not be acceptable.

E. Grounding of panelboards shall be as follows:

1. Bond grounding bushing on feeder conduit to the ground bus in the main distribution boards and to ground lug in each panel with a ground conductor.

F. Grounding of motors shall be as follows:

1. Provide ground conductor from grounding lug in the respective power panel or loadcenter to motor frame. Terminate in motor conduit terminal box if the terminal is mechanically connected to motor frame. If this is not feasible, extend ground conductor through an insulated bushed opening in the connection box and connect to motor base.

3.07 RACEWAY SEALS

A. Conduits and ducts for incoming and outgoing electrical services to the building through the foundation walls shall be closed with seals set inside of the raceway systems at the foundation wall. The seals shall be installed so as to expand around the cables and the inside of the raceways when they are tightened so as to form a watertight seal.

3.08 SECONDARY DISTRIBUTION SYSTEM

A. Provide complete, a secondary distribution system for lighting and power, including feeders, sub-feeders, conduits, raceways, wireways, wires and cables, switches, fittings, contactors, controls, junction and outlet boxes, distribution panels, loadcenters, meterbanks, lighting fixtures, lamps, hangers, devices, and all other appurtenances incidental to and required for the complete installation of an electrical system in perfect operating condition.

B. In general, the electrical distribution system for lighting and power shall be extended from the main distribution panelboard to panelboards and equipment throughout the building at 208Y/120V, 3-phase, 4-wire for general lighting and motorized equipment. The dwelling unit service shall be extended from the meterbanks to the loadcenters at single-phase, 3-wire.

C. Wiring and Connections for HVAC and Plumbing Motorized Equipment:

1. Motors, dampers, and/or valves, pumps, fans, thermostats, temperature control devices, aquastats, etc. for the operation and control of HVAC and Plumbing and equipment will be furnished under Sections 15500 and 15400 of this Specifications unless noted or indicated otherwise.

2. Unless otherwise indicated, all power and interlock wiring for HVAC and Plumbing equipment shall be provided under this section of the Specification.

3. Provide all disconnect switches and starters that are not furnished as an integral part of the HVAC and Plumbing equipment making all electrical power and interlock wiring connections to same. Control wiring for the HVAC system and connections to the starting equipment will be provided under the HVAC work. Connections to starting equipment made by the HVAC Contractor to starting equipment provided by this Contractor shall be under supervision of this Contractor.

4. Provide all thermal switches required for the HVAC and Plumbing equipment that are not furnished as an integral part of a unit.

5. Provide all remotely located selector switches, stop-start stations and pilot lights including the control wiring to same for the operation of the Plumbing and HVAC system equipment. Provide the control wiring from the plumbing system control devices such as aquastats and others to the plumbing system pump starters and controllers.

6. Automatic temperature control system wiring and the devices required for the operation of same will be provided complete under Section 15500 of this Specification.

D. Building Equipment Wiring:

1. Provide and connect all raceways, fittings, switches, wiring and devices required for building service equipment that are relative to and part of this building contract. Obtain all required information, wiring and connection diagrams before the installation of any raceways or wiring for same.

2. Carefully review all architectural and equipment drawings during the bidding period for all such referenced building equipment that will require electrical connections.

E. Elevator Wiring:

1. Furnish, install and connect all required raceways, wiring, fittings, fused disconnect switches, devices, and other equipment as shown or required for the operation of the elevators.

2. Coordinate all work and the installation of same with the work required under the Elevator Section of this specification prior to the start of construction. Power wiring for the elevator shall be extended to and terminate at the line side terminals of the respective controllers under this section of the specifications. All wiring, equipment and connections from the load side terminals of the controllers and cab lights, safety switches will be furnished and installed and connected by the Elevator Contractor.

3. Disconnect switches for the elevators shall be of the fused type and shall be located as indicated by the approved elevator shop drawings. Provide in each elevator pit a duplex convenience outlet, lighting fixture and switch for the control of same. The exact location of the above referenced devices and lamps shall be as indicated on the approved elevator shop drawings.

3.09 FIRE ALARM SYSTEM

A. Provide complete in every respect, all equipment, raceways, wiring and connections required to provide a manual and automatic type fire alarm system throughout the building as shown on the drawings and as required by the intent of this specification.

B. Final connections shall be made under direct supervision of a representative of the manufacturer. The routing of all raceways through the Building shall be installed in a manner acceptable to the Architect.

C. Upon completion of the installation and before final acceptance of the building by the Architect, have a factory trained Engineer of the manufacturer inspect the system and shall obtain from him a notarized letter indicated that the system has been inspected and is in perfect operating condition. Defective material and operating features, if any, shall be corrected before the letter is issued by the equipment manufacturer.

D. The fire alarm system shall be interfaced with the City of Boston Fire Department through the municipal loop. Coordinate with the local fire department all interfacing connection requirements prior to the start of construction.

E. The fire alarm system shall be interfaced with the HVAC system for fan shut-down, and with the elevator controllers for elevator recall in the event of an alarm condition. This Contractor shall

coordinate all wiring and connection requirements with the HVAC and Elevator Contractors in the field prior to the submission of shop drawings for approval.

F. This Contractor shall furnish, and electrically connect all duct smoke detectors. The duct detectors will be mechanically installed by the HVAC Contractor.

G. Coordinate all work with the Fire Protection Contractor as related to the installation of alarm valves, flow and tamper switch for the fire protection system as well as all connections required for interfacing with the fire alarm system.

H. The fire alarm system shall be installed in conformance with the drawings, as hereinafter specified and equipment manufacturer's shop drawings.

3.10 TELEPHONE SYSTEM

A. Provide complete in every respect a telephone raceway system (except as required within the dwelling units) including all conduits, wireways, terminal backboards, and outlets leaving the entire installation ready for installation of telephone and cables by New England Telephone.

B. Provide all cabling within the dwelling units as indicated including modular pin receptacles. The coverplates for said receptacles shall be of the same finish as other devices and switch plates throughout the building.

C. Telephone cabling and conduit system shall be, in general, as shown on the drawings.

D. Provide an 1/8 inch nylon pull cord in each conduit and duct to facilitate pulling of cables in the future.

E. All work and the entire installation of same shall be coordinated with the New England Telephone Company, and shall be in full conformance with their requirements and recommendations.

F. Wall outlet coverplates shall be provided with a factory bushed hole, except those indicated in paragraph 2 above, and be of the same finish and manufacturer as all other device and switch plates installed throughout the building. All telephone outlet coverplates shall be provided under this section of the specifications.

G. Telephone backboards shall be 3/4 inch plywood. Refer to the electrical plans for the size backboards required. Where specific size backboards are not indicated, provide a 4 foot by 8 foot by 3/4 inch backboards for the mounting of telephone and cable television equipment.

3.11 CABLE TELEVISION SYSTEM

A. Provide complete in every respect a cable television raceway system including all conduits, wireways, and outlets leaving the entire installation ready for installation of cables by the local cable television company.

B. Furnish and install all cabling within the dwelling units, cable type as indicated.

C. The conduit system shall be, in general, as shown on the drawings.

D. Provide an 1/8 inch nylon pull cord in each conduit and duct to facilitate pulling of cables in the future.

E. All work and the entire installation of same shall be coordinated with the local cable television company, and shall be in full conformance with their requirements and recommendations.

3.12 LIGHTING SYSTEM

A. Obtain all information relative to the exact type of ceilings and suspension systems that are to be installed in the various areas of the building before ordering any recessed fixtures. Furnish the proper type fixtures applicable to the ceiling framing system used. If other than the type of fixtures specified are required for installation due to the type of ceiling construction, furnish and install the proper type fixtures compatible for use with the ceiling system.

B. Coordinate the exact locations of all lighting fixtures with the ceiling pattern during the construction period and before installing the fixtures. Refer to the Architectural Reflected Ceiling Plan for the exact location of all ceiling fixtures located in areas where there are hung ceilings. Interferences between lighting fixtures, HVAC diffusers and other equipment shall be brought to the attention of the Architect.

C. Each lighting outlet shown on the electrical drawings and/or shown on the Architect reflected ceiling plans shall be provided with a fixture or other lighting equipment of the type indicated and specified. In the event a type designation is omitted at any outlet, furnish and install a unit typical of those in similar areas at no additional cost to the Owner.

D. All surface and pendant mounting fixtures as well as recessed HID and incandescent fixtures shall be hung and supported from the structure completely independent of any hung ceiling systems, ductwork and piping. Provide steel channels where required to span ductwork and piping. Ductwork and piping that has been installed by the other trades shall not be used to support lighting fixtures. Surface and pendant mounted fluorescent fixtures in finished areas of the building shall be provided with two support rods per four foot fixtures; three per eight foot fixture.

E. Recessed fluorescent fixtures shall be supported by the hung ceiling system. Coordinate the location of supporting ceiling system wires in the field to insure that proper support is provided for the lighting fixtures.

F. Provide all lighting fixtures, complete with standard or special tile mounting frames, and supporting attachments, plaster frames for all fixtures recessed in plaster, lamps, ballasts, self-aligning hangers and all other appurtenances required for a first-class installation.

G. All installed lighting fixtures and equipment shall be set or hung true and shall be proper alignment in both vertical and horizontal planes.

H. All installation fittings that are normally considered fixture parts, including hangers, yokes, channels, frames, stems and other appurtenances essential to a satisfactory installation of all lighting fixtures and equipment shall be furnished and positioned unless specifically noted otherwise.

I. Unless otherwise specified or accepted, wall fixtures that mount on outlet boxes shall be fastened rigidly by stud attachments. All ceiling or wall mounted trims, whether canopies, frames, flanges or other special mounting attachment shall be correctly aligned and firmly positioned.

J. All installed lighting fixtures and/or lighting equipment shall be free of light leaks, warps, dents, juts, paint imperfections, or other faults which are a result of poor workmanship in installation.

3.13 REMOVAL OF TEMPORARY LIGHT AND POWER

A. This Contractor shall abandon and rewire the temporary lighting and power services and stringers when so directed by the Architect. Temporary lighting stringers shall be removed from ceiling plenum spaces prior to the closing of same.

3.14 EXCAVATION AND BACKFILLING

A. Excavation and backfilling required for equipment and raceways installed under this Section will be performed under EARTHWORK. Location, depth of excavation and the routing of same shall be under the direct supervision of this Section.

B. Necessary protection and pumping work required to keep the excavation areas free of water will be provided under EARTHWORK.

C. Necessary bracings and shoring requested to protect the sides of the excavation will be provided under EARTHWORK.

D. Provide all required information as to the locations, sizes, grades and elevations of all conduit, equipment and foundations requiring excavation and shall be responsible for same.

3.15 SLEEVES, INSERTS AND PLATES

A. Maintain in proper position all sleeves, inserts and anchor bolts supplied and/or set in place under this section. In the event that failure to do so requires cutting and patching of finished work, it shall be performed as directed by the Architect.

B. Unless otherwise specified herein, all conduits and cables passing through floors, walls or partitions shall be provided with sleeves having an internal diameter one inch larger (minimum) than the outside diameter of the cables and/or raceways passing through same.

C. Sleeves through outside walls, structural grade beams or sump walls shall be Schedule 40 black steel pipe 150 pound black steel slip on welding flange at the center of the sleeve and shall be painted two coats of bitumastic paint inside and outside. In structural grade beams, the space between sleeve and conduit shall be packed with fire and waterproof foam silicon.

D. Unless otherwise indicated and/or specified herein, all sleeves through structural concrete floors and interior masonry walls shall be Schedule 40 black steel pipe, set flush with finished wall or set one inch above finished floor surfaces.

E. Sleeves through interior walls adjacent to all building expansion or construction joints shall be two conduit size diameters larger than diameter of conduit installed.

F. Sleeves through interior non-masonry partitions shall be 22 gauge galvanized sheet steel, set flush with finished surface of partitions.

G. Sleeves passing through lightproof or soundproof walls, floors and partitions and through fire rated walls shall be made tight using approved fireproofing foam silicon. The density and mixture of the foam, as a minimum, shall return the rating of the sleeve openings to the full fire rating of the floor or wall.

H. Core drilling, when required, shall be performed under this Section after receipt of approval by the Architect and his Structural Engineer.

3.16 FASTENINGS AND SUPPORTS

A. Except where otherwise shown or specified, the following shall be observed throughout the project.

1. Fastenings to wood: wood screws or lag screws shall be used.

2. Fastenings to brickwork, masonry or concrete shall be made with the use of approved expansion bolts or inserts, or self-drilling Bulldog type anchors and drive pins. Inserts shall be of the type to receive machine bolt head or nut after installation.

3. The use of "Ramset" or other powder actuated tools will not be permitted.

4. The use of wood plugs and nailing will not be permitted.

5. Perforated iron for supporting will not be permitted.

6. Fastenings to steel structures and iron works shall be made by the use of granular flux filled welded studs similar to Nelson Stud Welding, Division of Gregory Industries or mechanical supports similar to Korn Clamps and/or pipe straps.

7. Korn clamps may be used as means of fastening horizontal runs of conduit to purlins, deep steel members and the upper sections of column flanges. The use of "C" type clamps will not be permitted as a means of permanent support to vertical conduit risers at columns.

8. Steel channels and flat iron should be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc. for a rigid installation.

9. Miscellaneous steel for the support of fixtures, boxes, starters, panels and conduits, shall be furnished and installed. Steel supports may be welded in place in accordance with applicable sections of the American Welding Society.

10. Approval must be received from the Architect before welding to any structural member.

11. The installation of all fastenings and inserts shall be included as a part of the work under this Section.

12. Supporting from suspended ceiling wires is prohibited unless approved by the Architect.

13. Building floor slabs and walls shall not be core drilled or cut without approval by the Structural Engineer and Architect.

14. Supplementary steel and channels shall be firmly connected to building construction in a manner approved by the Architect prior to the installation of same.

15. The type and size of the supporting channels and supplementary steel shall be sufficient strength and size to allow only a minimum deflection in conformance with the channel and supplementary steel manufacurer's requirement for loading.

16. Channels and supplementary steel furnished and installed under this section shall be hung from the building structure and not the support systems installed by other trades.

17. Unistrut and channels shall be run continuously under the ceiling channels and shall be coordinated with other trades for interferences.

18. Exposed raceway systems and lighting fixtures shall be hung by rod hangers and metal channels of proper size to support firmly and substantially the electrical raceway systems and lighting fixtures.

19. Raceway systems shall be properly secured to the channels.

3.17 PHASING AND COLOR CODING

A. Color coding shall be maintained for all feeders and branch circuit wiring throughout the project. Color impregnate insulation shall be used for all conductors up to and including No. 6 AWG. Conductors larger than No. 6 shall be identified by color banding tapes at all termination points, junction pull and outlet boxes.

1. Phases, neutral and ground conductors system shall be color coded as follows:

a. Phase A - Red

b. Phase B - Blue

c. Phase C - Black

d. Grounded Neutral - White

e. Equipment ground conductor - Green

B. The distribution panels, motorbanks and panelboards shall be phased, "A", "B", "C", either top to bottom or left to right. The neutral, although it may be in different locations for different equipment, shall be identified.

C. Phase orientation and rotation shall be verified prior to placing equipment into operation. Adjustments shall be made prior to the completion of the work under this Contract. All motors shall be checked for proper rotation with adjustments being made as required for the proper operation of motorized equipment.

3.18 TESTS

A. This Section shall include the making of the necessary tests referred to herein in the presence of the Architect to show that the particular system or equipment has been properly installed and is in good operating condition, as hereinafter specified. The Architect shall be notified two (2) weeks in advance of the date for all tests so that he may be present to witness the tests.

B. Complete test and inspection records shall be made and incorporated into a report for each piece of equipment tested. Readings taken

shall be recorded. Six (6) copies shall be submitted to the Architect for record and comments.

C. Furnish necessary meters, instruments, temporary wiring and labor to perform all required tests and adjustments of equipment and wiring installed and/or connected under this contract, including electrical equipment furnished by others, to determine proper polarity, phasing, freedom from grounds and shorts and operation of equipment. All measuring instruments shall be properly calibrated.

D. Materials and manner of installation shall be in strict accordance with the applicable requirements of state and local authorities, the Utility Company and the NFPA.

E. Following established procedures, equipment shall be energized after it has been determined by this Trade that the installation has satisfactorily been tested and ready to be placed in operation.

F. Wiring:

1. System and equipment grounds will be checked for proper value of resistance using the Megger ground tester in accordance with manufacturer's standard instructions.

2. Overall resistance of the ground system shall be no greater than 25 ohms. The grounding system shall be inspected to insure all above ground cables and connections are suitably protected. Provide additional ground rods, if required to obtain the specified resistance.

3. Ground resistance tests shall be made at all test points as required by the Architect. Ground resistance tests shall be made in accordance with the test procedures outlined in James G. Biddle Company Bulletin 25T2.

4. Correct or replace current-carrying circuits that are defective or grounded and correct all other defects encountered during the testing of the electrical systems. Defects whether through faculty workmanship or material furnished shall be corrected under this Section as a part of the Contract requirements.

G. Lighting: Check all lighting fixtures for proper operation and replace all noisy or defective ballasts and lamps.

H. Motors:

1. Make the following tests on all motors before start-up.

a. Check motor nameplates for H.P., speed, phase and voltage. Provide in the motor starters and contactors the proper size and type of thermal overload element required for the proper protection of the motor.

2. Make the following tests on all motors during or immediately after start-up:

   a. Check motor rotation. Motors rotating in the wrong direction shall be corrected.

   b. Take a current reading at full load using a clampon ammeter. If ammeter reading is over the rated full load current, determine the reason for the discrepancy and take the necessary corrective action.

3. Check all control devices, pilot lights and lockout switches to insure that they are properly connected. All lockout stations shall be operated to insure that motor control circuits will be de-energized, subsequently de-energizing the power feeder to the motors.

4. Overload elements in motor starters shall be checked for suitability to the motor characteristics. Replace any overload element that does not conform to starter manufacturer's recommendation based actual nameplate current rating of the motor. The cause of any motor operation above full load rating shall be investigated and the cause removed. Under no circumstances shall oversize overload relays be installed.

I. Fire Alarm System

1. The Contractor shall conduct tests of the system in the presence of the Architect.

2. At the completion of the work, the complete system shall be tested, by the approved service company, to the satisfaction of, and in the presence of, an authorized representative of the City of Boston Fire Alarm Division.

3. The test shall include all wiring and the proper operation of all equipment.

4. Tests shall be made of the operation of each automatic and manual alarm indicating device on the system, without impairing such alarm initiating devices.

5. Each device shall also be tested to ascertain that it operates on the designated zone and proper coding and also actuates the correct zone and trouble designation on the annunciators.

6. Additional tests shall be made as required by the Boston Fire Department.

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